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Improving Retention and Degree Attainment for Underrepresented Students in STEM: Is Experiential Learning the Solution?

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IMPROVING RETENTION AND DEGREE ATTAINMENT FOR UNDERREPRESENTED STUDENTS IN STEM: IS EXPERIENTIAL LEARNING THE SOLUTION?

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Education in the
College of Education
at the University of Kentucky

By
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2020

ABSTRACT OF DISSERTATION

IMPROVING RETENTION AND DEGREE ATTAINMENT FOR UNDERREPRESENTED STUDENTS IN STEM: IS EXPERIENTIAL LEARNING THE SOLUTION?

Experiential learning opportunities, such as undergraduate research, are found to be useful in promoting retention and graduation in STEM majors, and specifically for underrepresented student populations. These opportunities are being implemented throughout the United Stated as a means to improve student learning and persistence. In Kentucky's strategic plan, experiential learning activities are seen as an avenue to help students persist in college and are key components in helping the commonwealth reach their goal of sixty-percent of adult Kentuckians earning a college credential by 2030.

Mirroring the commonwealth's strategic plan, Northern Kentucky University (NKU) emphasized the importance for experiential learning opportunities and student success, particularly for underrepresented students. However, little is known about how these experiences are able to produce student persistence towards degree completion. McDevitt, Patel, Rose, and Ellison (2016) found that after participating in a summer research program, some students expressed a greater sense of respect as a member of the scientific community.

The present study investigates the influences of a summer research program on student science identity, sense of belonging and persistence in STEM. In-depth interviews with students, faculty, and administrators revealed how a summer research program can influence student persistence in STEM, especially for underrepresented students. Implications from this study suggest that undergraduate research programs that include faculty and peer interactions, career exploration, and the physical "doing" of research are likely to produce student persistence in STEM, particularly for underrepresented students. Limitations of the study, such as conducting the research in the midst of a global pandemic are discussed as well.

KEYWORDS: Experiential Learning, STEM, Underrepresented Students

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IMPROVING RETENTION AND DEGREE ATTAINMENT FOR UNDERREPRESENTED STUDENTS IN STEM: IS EXPERIENTIAL LEARNING THE SOLUTION?

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DEDICATION

To My Family.

ACKNOWLEDGMENTS

There are so many people who have encouraged me along this journey. I still recall telling my mother when I was six months pregnant with my first child, that I planned to pursue my doctorates degree in the upcoming fall. It was December at the time and I just graduated with my master's degree. She later told me she was nervous for me to take on so much at once, but she knew I was determined. So, in March my husband and I welcomed the birth of our first son, Caleb. And in August, I started the doctoral program. Like for many, balancing a full-time job, family, and school certainly presented its challenges, but I thank my family for keeping me encouraged and helping me along the way. To my husband, Earmon, who always had an encouraging word and a funny joke to keep me going. To my parents, who instilled the value of an education in me and my siblings from a very young age, I am only here because of you. And to my grandparents, who, when I was four, my grandmother made me and my sister count aloud to 100 using a handmade poster board chart and my late-grandfather, who was illiterate, and always told me to "get an education", because he didn't have the opportunity to go to school and had to drop out of grade school to help his family on their farm. This degree is for you.

I want to thank my dissertation chair and "coach" Dr. John Thelin for helping me throughout the dissertation stage. There were times when I felt completely discouraged and Dr. Thelin helped to talk me off of the edge. Thank you, Dr. Thelin for seeing me through. Thank you to Dr. Willis Jones, my former chair and committee member, who helped me to think through my dissertation topic and helped to make it a reality. And to Dr. Cindy Jong and Dr. Jungmin Lee, also members of my dissertation committee, who shared literature within their courses that put me on the path to investigate STEM student

success. Your coursework helped shape my dissertation and inspired me to be an active agent of student success at my institution.

Most importantly, I thank God. I wouldn't have made it through this journey without His grace and strength.

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CHAPTER 1. INTRODUCTION

1.1 Problem Statement

Recognizing the need for a more educated population to meet market demands, the Kentucky Council on Postsecondary Education (CPE) set a statewide goal of 60 percent of adult Kentuckians to hold a postsecondary credential by 2030. This push to educate more citizens within Kentucky is also to attract higher paying jobs to the state, such as careers within science, technology, engineering, and mathematics (STEM). CPE recognizes in order for the state to appeal to more STEM-based companies, Kentucky must have a career-ready workforce. Under the CPE state strategic plan, each state post-secondary institution was charged with a credential attainment goal, including a STEM goal (CPE, 2016). Many public higher education institutions within the state began to create initiatives to meet the ambitious statewide credential attainment goal.

In light of the new state strategic plan, former Governor Matt Bevin signed into law Senate Bill 153 in 2017, which established a new funding model for all public state institutions that would be based on institutional performance, student enrollments, instructional and student spending, and facilities costs. The new model would go into full effect in 2018 (CPE, 2016). In the first full implementation year, Northern Kentucky University (NKU) was outperformed on almost all performance funding metrics when compared to the other public 4-year institutions. This resulted in a loss of thousands of dollars for NKU. With over a third of the performance funding attributed to student persistence and degrees awarded, including specific metrics tied to STEM areas, it is imperative for NKU to improve the success rate of students within STEM majors.

In 2018, Northern Kentucky University met with community partners, local

businesses, high schools and current students to build the next university strategic plan that would align with the CPE state plan. NKU was interested in knowing how they could meet their constituents' needs and what the institution needed to improve upon to foster student success. After receiving thousands of responses from students, faculty, community members and local businesses, the university created a framework that was rooted around three pillars, or themes; student access, student completion, and career and community engagement. These pillars were considered the foundation of student success and mirrored the three themes of the state plan; opportunity, success, and impact (NKU, 2019).

With a new framework in place, the next challenge for NKU was understanding just how they could improve student success. What types of initiatives would help students complete their degrees, especially students from underrepresented populations, such as first generation, economically disadvantaged, and racially minoritized groups? Throughout the strategic framework, NKU highlighted the need to create pathways and programming to assist underrepresented student populations in being successful at NKU. With a first generation undergraduate population of nearly 47 percent and an underrepresented minority (URM) enrollment increase over the last several years, the university recognizes the importance of serving the unique needs and challenges of these student groups and established specific goals and objectives under the new strategic plan to specifically create initiatives to foster success for these student populations.

Experiential learning activities, such as research with faculty, internships, and externships, were noted by NKU as a solution to help students attain their degrees. These activities, praised by national experts as significant predictors of student retention and

completion (National Survey of Student Engagement [NSSE], 2007), are an initiative the university plans to expand upon in order to increase student degree attainment. According to the experiential learning theory, experiential learning is defined as a "dynamic, holistic theory of the process of learning from experience" (p. 11, Kolb & Kolb, 2017). Students engage in an experience, abstract lessons from the said experience, then reflect on what was learned through the experience. This form of learning puts the student as the center of learning and allows them to glean knowledge from the experience. Because of this dynamic form of learning, institutions across the nation, including NKU, are trying to find more ways to incorporate experiential learning into their curriculum.

Currently, NKU has a 43 percent six-year graduation rate, which is over ten percentage points below the overall Kentucky graduation rate of 54 percent (CPE, 2019b). Experiential learning activities were highlighted as one of the top initiatives for the university's pillar of career and community engagement. Furthermore, the institution set a goal to implement these experiences within each academic major, ensuring that all students have the opportunity to participate in these career related activities.

In order to be successful, NKU would need to find best practices for implementing experiential learning activities throughout the campus. Although many researchers have noted the positive impacts of experiential learning on student retention and graduation, there is less research on the specific factors that ensure a successful experience for students. Often research studies compare the retention rates of students exposed to experiential learning to those who have not had similar experiences, but less is shared within these studies on the details of the experiences. So how would NKU implement these activities on campus successfully? The current research study proposes

an examination of a current NKU program that has demonstrated a successful impact on student persistence, particularly STEM persistence. The proposed study will investigate why the program has been successful and what components of the program as well as psychosocial concepts influence student persistence in STEM. The subsequent sections outline the following; (a) current context of the issues surrounding successful implementation of experiential learning opportunities campus wide both broadly and specifically at NKU, (b) typical components of experiential learning activities, and (c) psychosocial components related to experiential learning activities and STEM persistence.

CHAPTER 2. HISTORICAL CONTEXT AND LITERATURE REVIEW

2.1 Current Knowledge on the Problem of Context

In a 2012 occupational forecast for the Greater Cincinnati metropolitan area, computer and mathematical science occupations were expected to gross nearly 7,000 jobs by 2020 (Center for Economic Analysis and Development [CEAD]). Furthermore, the state of Kentucky is expected to employ over 74,000 people in science, mathematics, and engineering occupations by 2026 (Kentucky Center for Statistics, 2016).

In response to these economic and workforce needs, the commonwealth of Kentucky set a postsecondary credential attainment goal of 60% by 2030. In 2016, only 45 percent of Kentuckians had earned postsecondary credentials, which was lower than the national average of 52 percent. Kentucky officials believed that achieving an educated community could stave off chronic social plagues such as poverty, addiction, disease, and incarceration (CPE, 2016). Not only that, but a well-educated state could

lead to more tax dollars. In 2015, CPE commissioned University of Kentucky's Center for Business and Economic Research (CBER) to study the positive effects of increased levels of educational attainment. CBER found that if Kentucky was as well-educated as the national average it could translate into an additional $370 to $534 million in tax revenue annually. Such lucrative financial and social promises led the commonwealth to set an ambitious goal of over half of the adult population to hold postsecondary credentials by 2030 (CPE, 2016).

Once the goal was set, CPE began to create a detailed strategic plan that articulated objectives and strategies necessary to meet this goal. Objective 9 of the plan called for improvement in "career readiness and employability of postsecondary education graduates" (CPE, 2016, p. 17). Objective 10 called for an increase in research to create "new knowledge, accelerate innovation, and promote economic growth" (p. 17). To do so, CPE outlined the following strategies:

> 9.3. Work with the employer community, foundations, and state agencies to provide "work and learn" opportunities, including experiential or project-based learning, co-ops, internships, externships, and clinical experiences.
>
> 9.6. Advance Kentucky's STEM and health agendas through ongoing leadership, advocacy, and collaboration.
>
> 10.4. Increase opportunities for undergraduate students to conduct or assist in research (CPE, 2016)

Throughout the state's plan, there is specific language that calls public universities and institutions to address the need for experiential learning opportunities in

order to ensure student completion and to boost the number of graduates within STEM fields.

In the conclusion of the state plan, CPE outlined the course for implementation. One of the key strategies for successful implementation was to ensure that all public universities and colleges created institutional plans that aligned with the goals and objectives of the state plan. This led NKU to formulate their new strategic plan, Success by Design. Throughout the Success by Design framework are strategies and language that parallels the commonwealth's plan. For example, the vision of NKU's plan states:

> NKU will be nationally recognized for being a student-ready, regionally-engaged university that empowers diverse learners for economic and social mobility (NKU, 2019).

This vision encompasses the essential elements of the state's plan that has a focus on economic growth and degree attainment for a variety of population groups. Not only does the university vision align with the state, there are several objectives and strategies that echoes the CPE's plan as well:

> Increase the number of first-generation, post-traditional, international, and underrepresented students at NKU, particularly in fields where their underrepresentation is most significant.
>
> Increase flexible, experiential and modular learning pathways that allow students to earn credentials along the way to their degree, and implement components of competency-based education in majors where possible.
>
> Build experiential and co-curricular learning into all majors at NKU to enhance

our students' career readiness and lifelong learning (NKU, 2019).

Again, similar to the commonwealth, NKU recognizes the importance of experiential learning in the retention and completion of students. Therefore, experiential learning is highlighted as a key tactic to retaining and graduating more students, specifically students within STEM (NKU, 2019).

With state and university plans clearly outlined and articulated, execution is still key in the successes of these plans. Given the current state of degree completion at both the university and state levels, there is much work to be done to meet the state goal, particularly in the areas of STEM fields, as these degrees only made up a small fraction of overall state and university degree earners at the implementation stage of these plans in 2017.

Since 2017, overall NKU undergraduate enrollment has declined by four percent, STEM enrollment has declined by over ten percent. Retention of first-time, full-time STEM students have declined as well, with a third fall retention rate of 33 percent for the 2015 cohort to a 28 percent rate in 2017. Similar retention declines have been experienced for URM STEM students as well. Furthermore, STEM degrees have remained stagnant, only accounting for 14 percent of overall bachelor's degrees in 2018-19. Of those STEM degrees awarded, URM students only accounted for six percent, compared to 12 percent of all bachelor's degrees earned (CPE, 2019b).

The challenge to retain and graduate more underrepresented students within STEM majors is not unique to NKU, but is a national concern as well. In 2007, the National Academies' Committee on Sciences, Engineering and Public Policy issued a call

to action to improve the current state of science-related education and programming. Yet by 2015, only 18 percent of all bachelor's degrees conferred were within science, technology, engineering, and mathematics (STEM). Furthermore, African American and Hispanic STEM degree earners accounted for 12 and 15 percent of those degrees respectively (National Center for Education Statistics [NCES], 2019).

The same is true for the state of Kentucky. In 2018-19, the state's public institutions awarded over 12,000 STEM degrees. Of those STEM degrees, only eight percent were earned by URM students, and 18 percent were earned by low income students. Furthermore, women made up only a quarter of STEM degrees, compared to over half of all degrees earned for that year. Overall, the state of Kentucky has struggled to produce a more diverse STEM workforce (CPE, 2019b). This raises the concern as to who will be qualified to work in the new STEM-focused companies and careers Kentucky is wanting to attract to the commonwealth (CPE, 2016).

Understanding the high need to funnel more students within the STEM pipeline, many colleges and universities throughout the United States are creating STEM-focused experiential learning programs to remedy the inequities found in the persistence of underrepresented minority (URM) students and women in STEM majors. Espinosa (2011) found that for women of color, participation in such programs, specifically those that emphasize undergraduate research and creating a robust STEM community, improved their likelihood to persist in STEM disciplines. Lane's (2016) examination of experiential learning within a science support program for URM students found that students valued the sense of community and gaining knowledge on how to operate within the science community in order to be successful. Other scholars also have found similar

findings for students of color, particularly those that focus on faculty-student mentorships (Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011), student research (Ghee, Keels, Collins, Neal-Spence, & Baker, 2016), and student engagement (Fechheimer, Webber, & Kleiber, 2011).

Experiential learning activities, like research with faculty, are known to improve student retention and completion in STEM majors. In an analysis by Ghee, Keels, Collins, Neal-Spence, and Baker (2016), research with faculty was attributed to retaining more students within their STEM major, specifically for URM students. Therefore, NKU must find ways to implement these experiences within students' academic careers in order to ensure success, especially for underrepresented populations in STEM.

Experiential learning activities are not new to NKU. Throughout the university, there are pockets of departments and centers who have implemented these activities within the academic curriculum. However, student participation in these activities are sporadic, and often do not occur until many students' senior year of their postsecondary academic careers. In the institution's 2018 National Survey of Student Engagement (NSSE) results, only about half of seniors had participated in an internship. Furthermore, NSSE recommends that freshmen participate in at least one experiential learning experience by the end of their first year. According to the 2018 results, approximately half of all first-year students surveyed participated in such experiences, trailing behind benchmark comparison group institutions as well (NKU, 2018).

Not only has student participation in experiential learning been lagging at NKU, the ability to track such experiences university-wide has posed issues as well. Currently, the only experiences that are tracked are those that students take for credit. Any

experiences that the student acquires on their own, such as paid research experiences outside of the university, are not included within the university data. This gap in tracking such experiences creates a challenge for the institution to truly assess overall student participation.

Currently, NKU has adopted the National Association of Colleges & Employers (NACE) criteria of experiential learning, which states:

1. The experience must be an extension of the classroom: a learning experience that provides for applying the knowledge gained in the classroom. It must not be simply to advance the operations of the employer or be the work that a regular employee would routinely perform.
2. The skills or knowledge learned must be transferable to other employment settings.
3. The experience has a defined beginning and end, and a job description with desired qualifications.
4. There are clearly defined learning objectives/goals related to the professional goals of the student's academic coursework.
5. There is supervision by a professional with expertise and educational and/or professional background in the field of the experience.
6. There is routine feedback by the experienced supervisor.
7. There are resources, equipment, and facilities provided by the host employer that support learning objectives/goals (NKU, 2016).

These criteria focus on the benefits that are provided to the student in order to further student learning and knowledge within their area of focus.

2.2 Discussion of existing data/background relevant to issue

Implementing experiential learning activities are not always a guarantee of student academic success. In a literature review by Sadler Burgin, McKinney, and Ponjuan (2010), they found that research experiences were not always the best predictors of success. One potential reason, as suggested by Sadler Burgin et al., could be the specific components that make up the experiences were not in place. This could be student to mentor/researcher matching, student interest aligned with the research, and other essential components. Presently, there is not much research on what components make a successful program. However, there are some factors that are typically found within an experiential learning program.

One factor is that the program must be structured. Research programs that are structured and provide explicit outcomes are more likely to be successful and report significant perceived gains from students (Thiry, Weston, Laursen, & Hunter, 2012). Thiry et al. found that undergraduate research experiences that provided students with continuous feedback, clear objectives and instructions of the research study, and guidance on how to apply newly acquired skills, were more likely to be satisfied with their research experience and express greater research skill gains.

Another key factor is that faculty and graduate research assistances involved in undergraduate research programs should provide quality mentor-mentee experiences. In a synthesis of research studies on undergraduate research experiences over the last five years, Linn, Palmer, Baranger, Gerard, and Stone (2015) noted that mentors act as student guides and help students to create a sense of scientific identity by helping them to visualize themselves in active roles within the science labs. Linn et al. also mentioned

that mentors help students to recognize gaps in their science knowledge and how to navigate future coursework to fill these knowledge gaps. Although Linn's et al. review found that students benefit most from faculty mentors, many of the studies within their review used graduate students and post-doctoral students as mentors.

Furthermore, mentorships within the context of experiential learning opportunities can provide great benefits from underrepresented student groups within STEM as well. For example, URM students report higher gains from research programs when they are able to relate to their research mentor and receive advice and experiences that go beyond academic research (Rodriguez Amaya, Betancourt, Henry Collins, Hinojosa, & Corona, 2018; Schwartz, 2011). Hernandez et al. (2017) examined factors related to high-quality mentorships among Black STEM students and faculty mentors and found that frequency of mentor-mentee interactions impacted student perception on the quality of the mentorship. Hernandez et al. also found that perceived similarities between mentor and mentee influenced quality of the mentorship, even those beyond racial and gender similarities. These findings suggest frequent interactions with faculty for URM STEM students can have positive influences on student satisfaction with their experiential learning activity.

Undergraduate research is time intensive for faculty as well as students. In a case study conducted by Schwartz (2011), faculty reported spending 10–16 hours a week engaged in these relationships teaching, modeling, supervising, assessing progress, networking, presenting at conferences with students, career counseling, mentoring students on family or personal problems, and academic acculturation. Therefore, in order to maintain faculty participation, undergraduate research programs must be valued and

accounted for within the tenure/professorship process. Many faculty feel pressured to drop such activities because they conflict with other departmental priorities and are not given much weight within the tenure process (Schwartz, 2011).

Finally, in order to see true gains in STEM persistence and graduation, students must participate in more than one undergraduate research program (Fechheimer et al., 2011; Ghee et al., 2016; Rodriguez Amaya et al., 2018; Thiry et al., 2012). In a correlation analysis, Fechheimer, Webber, and Kleiber (2011) found that students who participated in undergraduate research had higher GPAs at graduation than students who did not participate, even after controlling for SAT score. However, findings were only significant when students participated in two or more research opportunities. These significant findings held true also for differences in gender. Researchers also found that URM students experience high gains in STEM persistence when the undergraduate research experience goes beyond one opportunity (Rodriguez Amaya et al., 2018; Schwartz, 2011).

2.3 Theoretical Framework related to Experiential Learning

Sense of belonging and science identity are known to be large influencers of student persistence in STEM, specifically for underrepresented students (Carlone & Johnson, 2007; Espinosa, 2011; Jackson, 2013). Rainey, Dancy, Mickelson, Steams, and Moller (2018) found that sense of belonging and science identity were significant influencers of STEM commitment for women and students of color. Espinosa (2011) noted that women of color were more likely to persist in STEM when they had opportunities to participate in undergraduate research and feel a part of the STEM

community on campus. The following review of the literature examines both the uses of these activities in STEM and the psychological concepts of sense of belonging and science identity that underline the success of STEM persistence for underrepresented students.

Sense of belonging. Interactions between a student, peer groups, faculty, and campus environment can have an impact on a student's sense of belonging. Sense of belonging can be described as when one's own personal values connect with the values and norms of the organization (Bonous-Hammarth, 2000). Students feel a sense of belonging within the campus climate when their values and individual characteristics are embraced and valued within the campus community. In order for students to persist in STEM, they must feel like they are a part of the STEM community.

McDevitt, Patel, Rose, and Ellison (2016) found that after participating in a summer research program, some students expressed a greater sense of respect as a member of a scientific research team. This sense of respect and belongingness to the science community also was a predictor of higher self-assessment of research skills at the conclusion of the summer research program. McDevitt and colleagues suggested that facilitating a "culture of respect" in a collaborative learning environment can reinforce students' interest in STEM and empower them to be active learners. This is especially crucial for the success of underrepresented students. Research has found that sense of belonging for underrepresented students, like students from Latinx backgrounds, can impact their transition into college. Hurtado and Carter (1997) examined perception of sense of belonging for Latinx students and found that students who had higher ratings of sense of belonging were more likely to persist in college. Additionally, Bonous-

Hammarth (2000) found that URM STEM students were more likely to leave STEM majors when they were in campus environments that did not provide a welcoming and belonging environment.

Experiential learning opportunities can be used to foster belongingness for underrepresented students. In a study that examined the impact of a program that emphasized undergraduate research experiences for URM students, Ovink and Veazey (2011) discovered that the program not only better prepared students with scientific skillsets, but provided a supportive community of like-minded peers to help in the transition and learning of the sciences subculture. The students were able to build "social and subcultural capital", which helped them to feel that their STEM goals were more attainable. Rainey et al. (2018) found that STEM students who reported a greater sense of belonging were more likely to remain in STEM majors than those who left STEM. Furthermore, women of color were the least likely to report a sense of belonging to the STEM community and thus more likely to leave STEM.

Sense of belonging is critical for first generation students as well. First generation students often need validation that they belong in college and are valuable contributors to the campus, this is especially true for STEM first generation students (Kezar & Holcombe, 2017). In a multi-campus STEM collaborative project, California State University (CSU) established multiple STEM initiatives in order to improve the persistence rates for underrepresented students in STEM, such as first generation students. They found that campuses that were able to implement high impact practices (i.e. experiential learning) were more likely to foster a sense of community and belongingness for first generation students who often need opportunities to learn more

about various STEM careers than their continuing-education counterparts (Kezar & Holcombe, 2017). Chapman, Hill, Nagel-Myers, and Ramler (2019) experienced similar results within their STEM support program that targeted high achieving Pell-eligible students. Students who participated in the program commented on the opportunities to gain basic skills first-hand and how these experiences helped them to engage with their peers and faculty, which led to a greater sense of belonging within the STEM community.

These studies suggest that in order for URM, female, and other underrepresented STEM students to be successful, they must feel connected to the STEM community. Factors contributing to STEM sense of belonging are interpersonal relationships, perceived competence, personal interest, and science identity (Rainey et al., 2018). Experiential learning opportunities and initiatives created to improve underrepresented students' persistence in STEM must consider the impact of STEM sense of belonging. Experiences need to consider providing social networks where students can connect with the STEM community and build a relationship with other students and faculty within STEM (Kezar & Holcombe, 2017; Ovink & Veazey, 2011).

Science identity. According to Carlone and Johnson's (2007) model, science identity is made up of three components; competence, performance, and recognition. Competence is built through student science experiences and opportunities to build scientific knowledge. Then, students are able to perform the skills in which they have learned that are relevant to science practice. And when successful performance of science skills and practices lead to positive recognition by professors, peers, and meaningful others, students are able to develop strong science identities. From this science identity model, it is clear to see how experiential learning, such as undergraduate research, can be

pertinent in developing potential scientists, particularly students from underrepresented backgrounds.

Chemers, Zurbriggen, Syed, Goza, and Bearman (2011) found that such activities are mediated by science identity and self-efficacy, which then impacts student success and persistence in STEM. In a series of studies conducted with URM STEM students, Chemers et al. found that science identity mediated the association between research experiences and STEM career commitment. This means that research experiences were only able to influence STEM career commitment if those same experiences were perceived to improve student science identity. These findings suggest the importance of science identity on STEM persistence, especially for URM students.

In a longitudinal study, Robinson, Perez, Nuttall, Roseth, and Linnenbrink-Garcia (2018) were interested in how science identity was developed over time and how science identity predicted the pursuit of a STEM career post-graduation. Robinson et al. found evidence of three classes of science identity that are developed over time; High with transitory incline, which are students who have high science identity in their freshman year and generally maintain a relatively high science identity throughout college; Moderate-high and stable are students who have a moderately high science identity in their first year with little to no change over four years; and Moderate-low with early decline are students who had a low science identity in the first year and then experienced a sharp decline in the following year, with a less dramatic decline in the final two years. Similar to Chemers et al. (2011), students with high science identity also possessed high self-efficacy and believed that they were capable of performing scientific procedures and hypothesis testing. Students in the highest science identity class were more likely to

pursue STEM careers post-graduation as well. Furthermore, Robinson found that women and URM students were least likely to be in the class with the highest level of science identity and thus less likely to pursue STEM careers compared to their male, Asian and White counterparts. For first generation URM students, when they are able to view science as an opportunity to meet prosocial goals, they are able to find greater congruence between their personal/cultural and science identities (Jackson, Galvez, Landa, Buonora, & Thoman, 2016). Piatt, Merolla, Pringle, and Serpe (2019) found that both faculty mentoring and research involvement are related to higher levels of science identity and graduate school enrollment for low income, first generation and URM students. These data suggest the importance of building a science identity through experiential activities in order to increase the likelihood of underrepresented students to pursue STEM careers.

2.4 Undergraduate Research: Addressing Issues of STEM Community and Science Identity

Structured undergraduate research programs allow undergraduate students to assist a faculty member or graduate research assistant in formalized research. These activities can include gathering and collecting data, data entry, data cleaning, data analysis, and initial write-up of the results (Ovink & Veazey, 2011). Several studies have found that undergraduate research programs can improve student retention and graduation in STEM as well as likelihood to pursue graduate or professional school post-graduation (Fechheimer et al., 2011; Ghee et al., 2016). Undergraduate research programs are so successful because they allow students to cultivate their research skills and thus improving their self-efficacy and confidence (Ghee et al., 2016).

These improved skill-sets and self-efficacy hold true for underrepresented students participating in undergraduate research as well. Ghee and colleagues (2016) found that students who engaged in research preparation activities during their summer research program reported significant gains in research skills after completing the research program.

Undergraduate research is an excellent experiential learning activity that fosters the essential components of sense of belonging and science identity for STEM students, specifically for underrepresented student populations (Carlone & Johnson, 2007; Chemers et al., 2010; Lane, 2016). Undergraduate research experiences (URE) are known to enhance research skills and proficiency, interest in research careers, and an interest in pursuing a graduate degree (Lopatto 2010). UREs have a greater impact on STEM persistence for URM, first generation, and women students. There have been specific calls at the federal, state, and university levels to increase URE for STEM students in order to increase persistence and degree attainment (CPE, 2016; NKU, 2019; Obama, 2009). The President's Council of Advisors on Science and Technology (2012) recommended colleges and universities to provide early engagement of students in research because of its impact on STEM persistence. Because of these recommendations, federal funding was allotted for undergraduate research and providing these research experiences for those underrepresented in STEM (National Science Foundation [NSF], 2013). The commonwealth of Kentucky has weighted STEM degrees higher in its performance funding model, with URM STEM degrees having greater weights. NKU calls for more of these types of opportunities for students within its strategic plan. Because of the demands and calls from all political levels for more UREs and the

research on the benefits of UREs on underrepresented student persistence in STEM, this research will focus on the impacts of a summer research program at NKU. To provide additional context of these benefits, the following segment details the previous research on UREs, specifically with students of color, women, first generation, and economically disadvantaged individuals pursuing STEM degrees.

URM and URE. Over the last several decades, there have been countless of studies that discovered that college campuses can often have a "chilly" campus climate for Black and Hispanic or Latinx students (Locks, Hurtado, Bowman, & Oseguera, 2008; Rainey et al., 2018). Students of color often report feeling isolated or excluded within the campus environment. Hurtado and Carter (1997) reported that perceptions of a hostile racial climate had negative effects on Latinx students' sense of belonging. Furthermore, Hurtado and Carter found that students who had frequent interactions with faculty were more likely to report higher sense of belonging. Research experiences with faculty provide STEM students the opportunity to interact with faculty and their peers in a research setting. These interactions are known to build sense of community and belongingness, especially for students of color. Hurtado et al., (2011) found that creating interactions and networks through research programs, particularly for URM students, can eliminate feelings of isolation and increase their persistence in STEM. In an undergraduate research program for URM students implemented by the New York City College of Technology, all 47 participants persisted in STEM, with many going on to pursue graduate school in a STEM discipline (Blake, Liou-Mark, & Chukuigwe, 2013). Often students of color report feeling more accepted within the research community after participating in a research experience (Banks, Fresquez, Haeger, Quinones-Soto, &

Hammersley, 2018; Hurtado et al., 2011).

Building networks and relationships with faculty through URE can influence student degree aspirations, especially for students of color. In a multi-institutional study, Eagan, Hurtado, Chang, Herrera, and Garibay (2013) discovered that URM students who participated in undergraduate research programs were more likely to report having intentions to enroll in STEM and non-STEM graduate and professional programs than URM students who did not participate in such programs. Furthermore, after participating in an undergraduate research program, Black and Asian American students showed significant increases in their intentions to pursue a STEM-related graduate program, more so than their White counterparts. UREs can help students generate a more tailored career path and trajectory as well. In a summer research program that targeted URM students from a 2-year institution, students reported that the research experience gave them a better sense of the field of study they wanted to pursue, helped them to identify which area of research they would want to focus on in the future, and it opened doors for other research and academic opportunities (Leggett-Robinson, Reid Mooring, & Villa, 2015). This suggests that UREs are critical to the STEM pathway for students of color.

UREs are well known for building students research skills, but it also can build cultural capital as well. For underrepresented students, understanding the nomenclature and nuances in STEM culture can present an impeding barrier, often derailing students, particularly students of color, from persisting in STEM. This lack of STEM discourse and "speech" can cause entering students in STEM to feel as though they don't belong or impose on their perceptions of science self-identity. Robnett, Nelson, Zurbriggen, Crosby, and Chemers (2018) found that students who received instrumental mentorship,

such as task-focused mentoring, were more likely to report a higher sense of science identity. Falconer (2019) reported in her case study of Anne, a first-generation woman of color, that the budding researcher often felt displaced in the lab in some of her earlier research experiences because she didn't understand the scientific language that was often used within the lab setting. It wasn't until her second research experience with a doctor at a nearby hospital that she was able to learn the scientific words used in the lab. The more research experience that Anne received, the more she began to feel like a scientist. This suggests the need for early and frequent UREs for STEM students in order to help them acclimate to the STEM culture and discourse.

URE and Women. Similar to URM barriers to STEM persistence, women often face feelings of isolation within STEM. This is likely due to science being a male dominant field. Gender stereotypes of science emerge due to the dissonance between the expected roles of women in society and the expected roles of scientists in society (Aikens et al., 2017). Qualities often projected on to women include, agreeableness, nurturing, and passive, attributes incongruent with those of a scientist (Eagly & Karau, 2002). Studies have found that women tend to be positioned into "helper" roles instead of "producer" roles within STEM settings (Falconer, 2019). To overcome these stereotypes, women benefit from faculty interactions and mentoring, traits typically found in undergraduate research programs. In an NSF funded undergraduate research program with mostly women (54%), participants were more likely to persist in STEM than those who did not participate in the program (Gibson et al., 2019).

Furthermore, women in STEM might face challenges with stereotype threat or imposter syndrome, feeling as if they don't belong within the STEM community or that

they don't have the proper knowledge base to participate within STEM (Falconer, 2019). Having adequate experiences with undergraduate research is known to improve students' research skills and knowledge, thus impacting their science identity. Some of these skills include writing a hypothesis, conducting a proper literature review, reading research articles, and utilizing lab equipment (Leggett Robinson et al., 2015; Schneider, Bickel, & Morrison-Shetlar, 2015). In their study on the successes of women of color in STEM, Carlone and Johnson (2007) indicated that science identity not only came from doing science, but receiving recognition from meaningful others as a science person. In this study, women who received recognition from meaningful others within science were able to not only persist, but thrive within their STEM discipline. Offering opportunities to participate in undergraduate research can provide such recognition. Many who participate in research programs often have opportunities to present research findings at symposia and conferences (Gibson et al., 2019).

Interactions with faculty also are important for women in STEM and can impact their persistence in their fields of study. Aikens et al. (2017) found that women were less likely to have mentor relationships directly with faculty. In result, women reported lower science identity, likelihood to persist in STEM, publish research articles and pursue a STEM doctoral degree compared to their male counterparts. Furthermore, faculty who participated in UREs often reported helping students to learn research skills and discourse as well as helping students to overcome frustrations with conducting research. This benefit of faculty mentoring within UREs is essential to women success is STEM.

URE and First Generation. Parental educational attainment can have an impact on student outcomes and career aspirations. This could be due to a lack of access to

academic social capital and norms (Ostrove, Stewart, & Curtin, 2011). Continuing education students are able to use their parents' knowledge of the higher education system. For example, continuing education students are more likely to apply for scholarships and grants and complete a FAFSA earlier than first generation students (McKinney & Novak, 2015). First generation college students sometimes struggle with navigating the academic culture and are often not as familiar with middle-class norms and the "hidden curriculum" (Banks et al., 2018; Grineski, Daniels, Collins, Morales, Frederick, & Garcia, 2017). First generation students might have a smaller stock in academic social capital, but they might have a larger stock in community cultural wealth, which can help them persist through college. Their community cultural wealth might include a sense of commitment to community well-being, skills to navigate through social institutions, maintaining high aspirations through difficult circumstances, and the capacity to challenge inequality (Yosso, 2005).

Access to undergraduate research opportunities can help first generation students learn science norms and discourse, but these experiences must be strategic and intentional. Grineski et al. (2017) found that first generation students who participated in undergraduate research were still less likely to publish research and spent less hours in undergraduate research than their continuing education counterparts. Furthermore, although undergraduate research had a positive association with research confidence for first generation students, continuing education students had a stronger association with research confidence. These findings suggest the importance of intentional planning of undergraduate research objectives for underrepresented student populations, such as first generation individuals.

The California State University Louis Stokes Alliance for Minority Participation (CSU-LSAMP) Alliance comprised of 23 campuses and offers a wide-range of support systems for underrepresented students, such as URM and first generation individuals, to help them persist in STEM. At the Monterey Bay campus (CSUMB), there Undergraduate Research Opportunities Center (UROC) provides undergraduate research experiences with faculty mentors. These opportunities are intended to help students learn and navigate the "hidden curriculum" of STEM by providing workshops to help students strengthen their written and oral presentation skills, which are used in their research presentations and conferences. Students are exposed to the hidden curriculum of academia through active dialogues about the nuances and nomenclature of the academic setting. After participating in this program, students often reported higher levels of self-efficacy, sense of belonging to the research community, and research confidence (Banks et al., 2018). These program outcomes highlight the importance of intentional research programing for underrepresented students in STEM.

URE and Economically Disadvantage Students. Similar to first generation students, access to academic culture capital is limited for college students from working-class families. Often, college students from lower SES households attended high schools with inadequate financial funding, thus limiting their access to certain resources, such as technology and advanced science and mathematics courses (Grineski et al., 2017). This lack of resources can cause challenges with STEM persistence for economically disadvantaged students. Furthermore, the cultural capital advantages of social elites are often invisible such that poor academic performance of working-class students, whose cultural capital runs incongruent to academia culture, is seen to reflect innate deficiencies

in academic ability (Bourdieu, 1986; Grineski et al., 2017).

Therefore, it is important to provide lower SES students opportunities to undergraduate research in order to build STEM cultural capital, science identity and persistence in STEM. It is important to note that students from working-class families often need to balance school and family obligations, such as taking care of younger siblings or working to pay for college (Grineski et al., 2017). In result, it is essential to provide research opportunities that do not conflict with family and working obligations for students within this economic demographic. Paid research opportunities also can provide working-class students the opportunity to get the experiences they need to build critical research skills as well as meeting family obligations.

Georgia Perimeter College, a two-year institution with 43% of its students receiving Pell, created a non-residential summer research program in partnership with two local four-year universities. The program provides three weeks of in-house mentoring with GPC faculty, which included an introduction to research concepts and training on basic research techniques and skills. Then students are partnered with graduate research assistances at the four-year institutions in an eight-week research experience. Of the twelve students that participated, each reported an increase in their comfort with science research, sense of belonging in STEM, and their likelihood to transfer to a 4-year institution. Students explained how the experiences helped them to "see themselves" as scientists and define themselves as scientists. Several indicated that the research program influenced them to consider pursuing graduate school in a STEM discipline.

These STEM research outcomes suggest the critical need for working-class

students to participate in undergraduate research. Underrepresented students in STEM, like working-class students, must be able to "see themselves" as scientists and as active agents of the STEM community. This mental model can be fostered through research experiences. UREs build research skills and discourse, especially for students who have been omitted from receiving advanced scientific and mathematic experiences due to insufficient funding within their secondary schools. Higher education institutions must provide these experiences early within the STEM careers for underrepresented students in order to close the skills gap and cultural capital that are perilous barriers to STEM persistence.

2.5 Statement of Purpose and Research Questions

Experiential learning opportunities have been found to be useful in promoting retention and graduation in STEM majors, and specifically for underrepresented student populations. Experiential learning activities provide STEM students with a sense of science identity, connects them to the STEM community, and allows them to perfect their research skills. Both the commonwealth of Kentucky and NKU have called for the use of experiential learning activities as a means to increase degrees in STEM areas, specifically for underrepresented students. NKU has even stated the need to make experiential learning mandatory for all programs.

This will be no small feat, and will take great effort on the university to be successful in implementing experiential learning campus-wide. There are several current programs at NKU that have shown promise in promoting student persistence and specifically persistence in STEM through experiential learning activities. Therefore, my

research questions are as follows:

1. How has the participation in a summer research program, UR STEM, influenced student persistence in STEM?
2. How have, if at all, a summer research program aided students from underrepresented populations in the development of science identity and sense of belonging in the STEM community at NKU?

Understanding how to replicate some of NKU's current successes with experiential learning activities will increase their chances of further success with an expanded program. Also, investigation into which components are most useful to underrepresented students, specifically in STEM, can ensure that these components are included within campus-wide experiential learning activities. From a broader contextual perspective, there is little research on why experiential learning activities work. Additionally, providing a theoretical framework in which to view these student persistence outcomes can provide more depth and understanding as to why these programs are successful. Researchers suggests the need for more rigorous qualitative studies to better understand the complexities of STEM programs (Museus et al., 2011). Thus, the current study attempts to investigate the innerworkings of these programs to seek intricate insights into the successes of experiential learning programs like undergraduate research experiences.

CHAPTER 3. METHOD

The current study investigated student and faculty perceptions on experiential learning activities, specifically undergraduate student research, and how these experiences influenced student persistence in STEM program majors. The study

primarily focused on understanding how the components of sense of belonging and science identity influence STEM persistence, particularly for underrepresented students in STEM. As previously stated, the existing literature suggests that experiential learning activities, like student research, can provide a sense of community and science identity for underrepresented students in STEM. The study conducted an explanatory, holistic, single case study that investigated the impact of a summer research program on student science identity and sense of belonging in underrepresented students in STEM. Underrepresented STEM student groups include first generation, female, financially disadvantaged, and underrepresented racial minoritized (URM) students. This study included interviews and a document analysis to examine the program attributes associated with science identity and sense of belonging.

3.1 Institutional and Program Context

Northern Kentucky University (NKU) is a mid-size, public comprehensive institution located in the mid-west. In fall 2018, STEM students made up approximately 20 percent of the overall undergraduate degree-seeking enrollment. Furthermore, 12 percent of women, 15 percent of URM, 18 percent of financially disadvantaged, and 18 percent of first generation undergraduate students were in STEM majors. Additionally, for first-time students who started in a STEM major in the fall of 2018, only about half (53%) continued in their STEM major by the following fall.

CINSAM. The Center for Integrative Natural Science and Mathematics (CINSAM) was established in 2000 by the Kentucky Council on Postsecondary Education (CPE), the commonwealth's postsecondary governing council. CINSAM was

to serve as NKU's Program of Distinction, a state initiative to reach the council's goal of national-level degree attainment by 2020. The center was funded using state funds from the Regional University Excellence Trust Fund for the first five years of the program. After receiving initial state funding, the university was responsible for ongoing funding and support. The center was created to enhance the teaching, learning and application of STEM at P-16 education levels within the northern Kentucky region with a primary goal of facilitating the recruitment, retention and graduation of STEM and STEM education students.

Under the direction of the first director, a math professor, Dr. Phillip Schmidt who was brought to NKU from Akron University to develop the program, there was focus on science and mathematics at every educational level and building relationships within the public and private sector within the northern Kentucky region. This included math and science continuing education courses for teachers; developing alliances for teachers, faculty, industry scientists and engineers; internship and research opportunities for college students in business and industry; and symposia to improve public understanding in mathematics and science.

When Dr. Schmidt retired in 2004, CINSAM had a series of interim directors between 2004 and 2017. In 2017, Dr. Madhura Kulkarni officially became the director of CINSAM. With a background in environmental sciences and fundraising, she continued to make progress on CINSAM's mission as well as finding new funding revenues for CINSAM's growing list of programs. Under her direction, she was able to solidify sponsorship funding from two major corporations; Toyota USA and Duke Energy. Furthermore, the center began hosting STEM+H day at NKU in 2018, which brought

over 300 high school students from across the tri-state area. This event included partnerships with the Cincinnati Museum Center and Kentucky Science Center. These types of events promote STEM within the region and STEM recruitment for NKU. Other strategies of STEM promotion by CINSAM includes; faculty research grants, which are "mini" grants that serve as seed money for faculty to develop their research in order to request funding from larger funders for their research; a summer celebration of student research that allows students to showcase their research findings from their summer research projects; STEM ambassadors which is a leadership development course that promotes peer mentoring and learning; STEM scholars, a faculty/student mentor program that builds sense of community for STEM students who are underrepresented in STEM; and UR-STEM, an undergraduate summer research program that targets underrepresented students in STEM.

As previously discussed, NKU and the commonwealth of Kentucky have explicit goals to improve STEM scholarship and degree attainment within the northern Kentucky region and throughout the state, therefore CINSAM is instrumental in bringing these goals into fruition. CINSAM recognizes that in order to meet the university and state STEM degree attainment goals, underrepresented students such as women and racially minoritized students must be a part of that strategy. From its proposed beginnings, CINSAM was structured to enhance the interest of underrepresented students in STEM through student research and scholarship. Based upon this foundation, CINSAM created the UR-STEM summer research program.

UR STEM Summer Research Program. The UR (undergraduate research) STEM program was piloted in 2010 with three students as part of a National Science

Foundation's (NSF) Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) grant. By summer 2011, 80 students submitted applications to participate in the program, 32 students were selected. Research projects were proposed by faculty from the Biological Sciences, Chemistry, Computer Science, Mathematics & Statistics, and Physics &Geology departments. At the inception of the summer research program, the objective was to provide students early experiences with research, thus focusing on students with no research experience, typically freshman or sophomore students. Projects came from across the STEM departments, where the program tried to provide equal funding to each of the departments.

NSF-STEP funding ended in 2016, but CINSAM was able to use departmental savings as well as NSF-FORCE funding to carry on the UR-STEM program. As the program began to mature over the years, CINSAM recognized the importance to engage underrepresented students in early research experiences in order to increase their persistence in STEM, and thus began to prioritize students who were women, first generation, economically disadvantaged and racially minoritized as well as students struggling in their lab courses. This application criteria are what make UR STEM what it is today.

The present program selection process follows three phases; faculty project application, student application, and student-project matching. For the faculty project application phase, the academic chairs within the STEM departments review the project proposals and approve those in which they deem appropriate for undergraduate research. Approved proposals are uploaded to the program's website for student review. The research projects include project description, required/preferred skills, and project

duration. Students can participate in an eight-week or four-week paid research project, ranging from $350-$1,400 stipend. Participating faculty also receive a $500 stipend and potentially additional funding for supplies. Students select up to three projects in which they would like to work.

Student applications are reviewed by CINSAM for program criteria checks and priority scoring based upon first generation status, low income (as defined as Pell received), URM status, and female in an underrepresented STEM major. Selected student applications are then matched to their indicated projects of interest and shared back out with the research faculty, scoring is not disclosed. Faculty select the student(s) in which they have an interest and then conduct interviews. After interviews are conducted, faculty make their final selections and share those back with CINSAM for a final review. If selected, students are paired with faculty. Due to budget constraints, not all students can participate in the program.

The objective of the UR STEM program is to provide underrepresented students in STEM early opportunities to engage in undergraduate research. These experiences are also expected to build student-faculty relationships as well as peer partnerships. Students are required to complete ethics training and write a reflection about what they learned from the research project. Students also are required to present their research findings at the Heather Bullen Summer Research Celebration.

Over the last two years, UR STEM has shown promising results in retaining and graduating underrepresented students who participated within the program. In 2017, 33 (91.7 %) of the 36 participants retained or graduated in a STEM major by fall 2018 (see Table 1). To provide context, the fall 2017 cohort second fall retention rate for all STEM

majors who continued in a STEM track at NKU was 52%. These programmatic retention rates are exemplary and an exploratory analysis on how the program is able to retain such a high number of students in STEM is worthwhile.

UR STEM was the selected site program due to its focus on early participation in undergraduate research and emphasis on these experiences for underrepresented students in STEM. Furthermore, UR STEM is the university's only formal undergraduate research program that targets underrepresented students across all STEM disciplines. Due to these programmatic features, UR STEM was selected for this case study.

Table 3.1 Retention and graduation data of URM STEM program participants

	Total Participants	# Retained or Graduated in STEM Major-Fall 2018	% Retained or Graduated in STEM Major-Fall 2018	# Retained or Graduated from NKU-Fall 2018	% Retained or Graduated from NKU-Fall 2018
UR-STEM 2017	36	33	91.67%	35	97.22%
UR-STEM 2018	28	28	100.00%	28	100.00%

3.2 Participant Selection

Purposeful sampling was utilized for this case study. The study was to include current and previous UR STEM student researchers, faculty researchers and program administrator of UR STEM. The objective was to get a representation of each underrepresented student type, including first generation, financially disadvantaged, female, and underrepresented racially minoritized students. Student participants could represent one or more of these subcategories. The definition of first generation used within this study is adopted from the federal TRIO definition, which classifies any

student whose parent/guardian's highest level of education is not beyond an associate's degree (U.S. Department of Education, 2017). The study adopts the CPE definition of financially disadvantaged, which is any student who receives a federal Pell grant (CPE, 2019a). The current study defines underrepresented racial minority (URM) students as students who identify within one or more of the following racial/ethnic categories; African American/Black, American Indian/Alaskan Native, Hispanic/Latino, and Native Hawaiian/Other Pacific Islander. This definition of URM is aligned with CPE's definition.

Participants were selected using the criteria outlined in the aforementioned section. UR STEM administrators sent emails on the behalf of the investigator to both current and former students within UR STEM. Program administrators sent an email on the behalf of the investigator to faculty researchers as well. Students who voiced an interest in the study were selected based on which criteria they met from the aforementioned selection criteria to ensure that all student subpopulations were represented. Demographic information was collected using an online survey conducted via Qualtrics survey software. Students who did not meet the selection criteria were not included in the study analysis.

3.3 Participants

Participants included three current and four previous UR STEM student researchers, five faculty researchers, and one program administrator of UR STEM. One initial student participant was not included due to not meeting any of the selection criteria. Final selected student participants included one underrepresented racial minority,

six White, one Pell recipient, five female, and two male students. Students' disciplines were representative across the STEM fields. STEM majors included were; biological sciences, chemistry, computer information technology, computer science, data science, mathematics, and statistics. Although no first generation students were represented within the data, all other demographic categories were represented. As previously stated, purposeful sampling was conducted. After the conclusion of the interviewing process, no new data emerged and the data appeared to reach a saturation point for both faculty and students. Therefore, the sampling concluded with seven students and five faculty researchers.

Table 3.2 UR STEM Study Student Participants by Selection Criteria

Selection Criteria	**Number of Participants**
Underrepresented Racially Minoritized	1
First Generation	0
Pell recipient	1
Female	5

Table 3.3 UR STEM Study Student Participants by Key Demographics

Student	**Current Student Classification**	**Gender**	**URM Status**	**STEM Field**	**First Generation**	**Pell Recipient**
SL	Senior	Female	Not URM	Sciences	No	No
ST	Senior	Female	Not URM	Technology	No	Yes
SM	Senior	Female	Not URM	Sciences	No	No
SY	Junior	Male	Not URM	Mathematics	No	No
SZ	Sophomore	Female	Not URM	Technology	No	No
SF	Sophomore	Female	Not URM	Mathematics	No	No
SI	Sophomore	Male	URM	Technology	No	No

3.4 Data Collection and Procedures

The data collection process included individual semi-structured interviews with students, faculty, and administrator, and analysis of program documents. Interviews with current and previous student participants focused on experiences within the program, specifically related to elements that support or hinder belongingness, factors that influenced student STEM identity development and how these elements and factors impacted their decision to persist in STEM. Interviews with faculty were used to understand faculty perception on how they impact and influence student sense of belonging and STEM identity and the influence of the program on student persistence. The program administrator interview was used to learn more about the program infrastructure, objectives and history of the program. Interview items were adopted and modified from Lane's (2016) study on science identity and belongingness for URM students within a STEM enrichment program. Probing and follow up questions were incorporated throughout each interview as necessary for clarity and deeper understanding. Follow up communications were conducted with several, but not all participants, for purposes of clarity and understanding.

The document analysis included application materials, program annual reports, grant reports, CPE and NKU's Board of Regents minutes and CINSAM and UR STEM webpages. These materials were used to create the program profile and better understand the historical context of CINSAM and UR STEM. The profile and historical context where then used to inform probing questions for participants in order to understand the program structure from the student and faculty perspective.

Using an interview protocol addresses concerns of reliability by providing a set of

open-ended questions that are consistent throughout each interview session. The three participant-type interview approach was conducted to address concerns of validity and reliability. Performing interviews with multiple participants of the UR STEM program, I can develop a more holistic picture of how the program influences STEM belongingness, identity, and persistence.

3.5 Interview Process

Student Interview. Student interviews began with the question "What has been your experience within your STEM major at NKU?" This question is posed to get a foundation about how their early experiences within their STEM program and classes have been. This question often leads to a probing question about interactions with faculty and peers within their major courses. Again, I want to understand how have their experiences been before the UR STEM program. Have they been pleasant? Have they been challenging? This question helps to set the tone for understanding their sense of belonging and science identity prior to the summer research program. The next pre-experience question I ask is "Why did you apply to participate in the UR STEM program?" This helps me to gain knowledge into their reasons for wanting to participate in an undergraduate research experience. I typically would follow up with "How did you hear about the UR STEM program?" I like to ask this question as a cross reference to how the program states in its policies and procedures on how they market and advertise the program. I often want to know if they heard about the program from a faculty member? Received an email? Or perhaps heard about it from a different source. The final pre-experience question builds off of the previous question by asking "What do you hope to gain from this experience?" This serves as a primer to the post-experience question and

helps me to understand what the student was expecting to gain from the experience. I also wanted to know if these expectations were in any way related to sense of belonging and science identity. Did the students hope to make new friends within their STEM major? Did they hope to better connect with faculty? Were they hoping to gain research skills? Understanding the students hopes and expectations for URE would help me to formulate what is most beneficial to students when they are pursuing these types of experiences.

I followed up the general pre-experience questions with four general post-experience questions. The first of these was "What did you learn from the UR STEM program?". This general question was intended to be open ended to allow me to explore the student's experiences within the summer research program. I would typically ask probing questions to better understand the experiences that they shared. The next question "Did the UR STEM program meet your expectations? Why or Why not?" was posed as a satisfaction type of question. It also allowed me to compare and contrast their response to the pre-question about what they hoped to gain. I want to know if these two responses were congruent to one another, or if there was conflict between the two. The last two questions asked about "what did the program do well?" and "What is the program lacking". These two questions helped me to gain knowledge on what aspects of the program were working well and what, from the students' perspective, needed improvement.

The next set of student questions were related to sense of belonging. The first question, "Thinking about the UR STEM program, has it helped you to feel like you belong? If so how?" was kept open ended because I wanted to know in what ways did it help to generate a sense of belonging, if at all. Did they feel belongingness to their STEM

major, or maybe the larger STEM community? I wanted to know what types of belongingness, if any, did the URE foster for students who participated. The final belongingness question posed was "Were there times where you felt like you did not belong?". This question recognizes that students might not always feel a sense of belonging within a research lab and thus addresses this concern. Both questions were intentionally left vague to allow the student to respond in any way they choose. These questions led to more in-depth probing questions to better understand the student's sense of belonging within the URE and how it developed their sense of belonging within STEM overall.

The final set of questions were related to science identity and the students' perceptions of seeing themselves as scientists and researchers. The first question, "How would you describe a scientist?" was posed to better understand the student's current perception of a scientist. I wanted to know what types of attributes did the students apply in their description of a scientist. The follow up question, "Do you see yourself as a scientist? Why or why not?" allows me to assess any incongruence or similarities in their definition of a scientist and their perception of themselves as a scientist. This led to more probing questions, often to better understand any inconsistencies in their definition of a scientist and perception of themselves.

The final structured question posed was related to STEM persistence. I asked "Are you thinking about changing your major? If so, what major are you considering?" I wanted to know if the student still planned to pursue as STEM major after completing the summer research program. For previous students, I still asked this question and also asked if they have ever changed their major since attending NKU. The persistence

question illuminates the decision-making process that students go through when considering a major change. I wanted to know how URE impacts this process.

Faculty Interview. As previously discussed, faculty interviews were used as a cross reference to better understand how UREs impact student persistence in STEM. As Hurtado et al. (2011) discovered, there are benefits to faculty mentorships in STEM that students do not realize exists. Thus, incorporating faculty perceptions and experiences can create a more holistic picture of UREs influence on STEM belongingness, identity and persistence. The first set of questions are general and begin with "How would you describe the UR STEM program?" This helps me to understand the faculty perception of the program and its intended function. I am typically looking to learn what features of the program do they highlight; how do they position themselves and other faculty in the description of the program? A common probing question is how did they hear about the program? The last two questions ask "What about the program is working?" and "What about the program is lacking?". Similar to the student question, I want to know their perception of the benefits of the program and what needs improvement.

The sense of belonging questions asked about how, as faculty, do they foster sense of belonging and do they perceive that the program fosters a sense of belonging. The specific questions were "Did you help students feel a sense of belonging within the summer research projects? If so, how?" and "Do you think the UR STEM program encourages faculty to create a sense of belonging with students within the summer research projects? If so, in what ways?" These belongingness questions were posed to better understand if sense of belonging was being fostered within the UR STEM program from the faculty perspective. I wanted to know if the faculty perceived themselves as

agents of fostering belongingness for students.

Faculty researchers also were asked questions related to science identity. These questions asked about their perceptions on student science identity. The first question "Did you notice a change or difference in students' science identity before and after the summer research project? If so explain?" explored the concept of science identity and if the faculty researcher perceived that UREs influenced this concept. The next question, "Were their ways that you tried to help students build their emerging science identity?" Similar to sense of belonging, I wanted to know if the faculty researchers perceived themselves as agents of science identity for students. The final question, "Do you think participating in UR STEM helps students to develop their science identity? If so, explain?" explores the faculty perception of the program as active agents of science identity for students. I wanted to know if the faculty members were aware of any program activities that address issues of science identity.

The interview protocols were used as a guide for the discussions with both students and faculty. As mentioned, I asked relevant and appropriate probing questions for clarity and depth throughout the interview sessions. The questions on the protocol were intentionally designed to be open-ended to explore the participant's experience within the UR STEM program.

3.6 Data Analysis

Analysis took an inductive approach as recommended by Seidman (2006) for qualitative research. A thematic analysis was conducted on the data. I transcribed each interview and noted statements of interest that appeared to be emerging themes. These

statements were highlighted and color-coded as emerging themes began to become evident within the data. I kept a list of each color-coded theme. I also marked and highlighted statements that needed more clarity from study participants. After completing this first initial coding of the data, I followed up with the participants whose statements needed more clarification. This follow up was done via email. I sent the full statement(s) to the participants to ask about the meaning behind their statement(s). After receiving clarity, I went back to the original statement to properly code the statement. The follow up was added to the transcription data.

After all the participant interviews were fully transcribed, a more in-depth analysis was completed by re-reading each of the highlighted and noted sections. Initial themes were re-configured or merged to create a more overarching theme. Themes that were often consolidated were themes that had statements that were coded as two or more initial themes. As I recognized this pattern within the data, the themes were merged together and renamed to an overarching theme. Also, after the initial round of coding, I began to noticed that many of the themes found within the student data were present in the faculty data as well. Therefore, in the second round of coding, I began to regroup themes across both the faculty and student data. The total initial themes between the two participant groups were twenty themes. After consolidation, a total of nine overarching themes remained. The final themes are discussed in the following results chapter.

CHAPTER 4. RESULTS

4.1 Foot in the Door

When I asked student participants why did they apply to the UR STEM program, four of the seven students used the phrase “foot in the door” or some variation of this

phrase. Many students saw the UR STEM program as an opportunity to gain skills that would help them gain additional experiences such as internships or other research opportunities. They viewed the URE as a “foot in the door” opportunity to jump start their careers in STEM. ST (all initials are pseudonyms), a sophomore within the mathematics and statistics department, is an exemplar of seeing UR STEM as a “foot in the door” or entry point into the research field:

> ST: I wanted to get into research and [UR STEM] seems like a very good entryway into doing so. The research field is something I'm thinking about career wise. So it seemed like a good place where I could do it and also still be in with my university.

ST liked the idea of being able to have an opportunity to do research without having the requirement of needing research skills or experience. SZ, a sophomore in a technology related major, echoed a similar sentiment:

> SZ: I had thought before that I wanted to participate in research at some point, and since [UR STEM] advertises like introductory research, you didn't need any background. I thought it would be really good, like stepping stone to get me to doing more research and just more opportunities. And I think I thought it would be like valuable to learn researching skills and working with others or working with another faculty member.

Several of the students wanted to take advantage of a URE opportunity that didn’t require any existing research experience. Many believed that the UR STEM program could help them land future internships that might require such skills. SY, a former participant of UR STEM who was approaching his Junior year, talked about how his faculty mentioned the experience would be a good resume builder:

> SY: I was referred to it from one of my professors from my class. He said that it would be a good opportunity to get some practice for doing database projects, as part of a resume builder. And then also learning how to use some of the tools that are going to be used for the real world.

SY talked about how his professor mentioned that the UR STEM opportunity would give him experiences he would need for the “real world”. SL, a student approaching her senior year, but participated in UR STEM her sophomore year, expressed, “I hadn’t had any research experience before that. So, I wanted to just do something to get my foot in the door and to get a little bit of background experience. It would help me with other internships and things that I could do in the future.” SL goes on to note that this was the biggest benefit of the program from her experience:

> SL: And what I like the most about it, what I got the most benefit out of it was probably getting my foot in the door in the research team because I ended up sticking with that program. And I've been in it for like upwards of two years now. So, I guess it really just provided me with some community that I really enjoyed and have benefited from.

Note that SL not only received additional opportunities from the UR STEM program, such as being a part of a research lab, but she attributed the experience to introducing her to a sense of community. The UR STEM program opened doors, not only to career-related opportunities, but to becoming a part of a research lab community. For her, this was the biggest benefit of the program. SL was not the only student to express this sentiment, SM, who also is a senior, shared similar feelings of belongingness:

> SM: So, I really didn't like, know about research before I did the program, and it was just like a kind of a new world to me. So [UR STEM] definitely helped open the door and let me like see behind the scenes, I guess, because I had no idea before that. So it definitely helped me feel like I belong in STEM more, actually doing research.

SM mentions how having the opportunity gave her a “behind the scenes” look at research. She believed that learning how research worked helped her to feel like she belonged to the STEM community.

As SL mentioned, the URE was an opportunity or entry way for other STEM

experiences, such as her working in a research lab for the past two years. For example, SL, SZ and SM talked about how UR STEM allowed them to present their research at state conferences:

> SZ: Yes, we're still working together to write an abstract and continue to work on the paper because we're trying to submit it to other conferences to present in the future.
>
> SL: Through this eventually, not after when I did the UR STEM, but a little bit later, I went to other poster conferences, so I got to dip into this STEM community.
>
> SM: And we also went to KS [Kentucky Science Conference] and presented. We got to see people from other schools too and what they were doing for their undergraduate research.

Note that these additional experiences fostered by UR STEM, led both GL and SM to meet other students within the STEM community. Having this research opportunity built their sense of STEM community as well.

Faculty also spoke of how UR STEM was a door of opportunity for students to have other experiences. Because of their work with students who participated in UR STEM, over time, they noticed how these opportunities were "stepping stones" for students within their STEM college careers. FM, a first-time UR STEM faculty researcher exclaimed "I'm happy with what she was able to get done. And, you know, I feel like now doors are more open for her and she's more confident." FM recognized that having this opportunity will not only afford her student researcher with more opportunities, but it has built her confidence to continue to pursue these research opportunities.

FN, a faculty member who has participated in UR STEM for over five years, gave an example of a student who used the UR STEM program as an entry point and

career starter in STEM:

> FN: I've got a student working at the center right now. I had him in the UR STEM, I later had him in class. Now he's working for me. Did those connections start with the UR STEM? Probably so.

Many of the faculty discussed how UR STEM was an entry point that allowed them as faculty researchers to continue to give these students opportunities. FL, a faculty member in his second year with UR STEM, mentioned that his department uses UR STEM students to encourage other early career students to consider participating in the program:

> FL: We've also then invited UR STEM students to give like, we have a day, like a colloquium TED talk, where they usually in the spring, we invite UR STEM students there … to actually present. And the last year they invited some of my UR STEM students to talk with our early majors about the opportunity and research and things like that. So, I think that it definitely is used and helps build that sense of community.

FL mentioned that the participation in UR STEM and sharing those experiences with other students can help foster a sense of community for the department. FA has been participating in UR STEM for over five years and he shared how he has seen this opportunity help students in getting into graduate school and other competitive programs:

> FA: I've been doing this long enough that some of them have actually applied to graduate programs and gotten in or they've applied for other summer research programs that are fairly competitive and this helps them get into that as well.

FJ, who has participated in UR STEM for over five years as well, stated how she often gives UR STEM students the opportunity to continue working in her lab after the summer research program is over:

> FJ: I always tell them the longer you're in the lab, the more skills you're going to gain. That first month is a lot of the grunt work and so, and I think that encourages them because they do see students that are juniors and seniors that are

doing higher level things, they're going to national conferences not just regional or on campus conferences.

FJ recognizes the importance of providing students the opportunity to continue doing research and that these experiences allow for other research related opportunities, such as attendance at national conferences.

Both students and faculty view the UR STEM program as a "door" to future opportunities. Some of the upper level students shared how UR STEM helped them to find additional research opportunities. Many of the sophomore students were hopeful to find such opportunities as well. Several faculty members have used the program as a potential "pool of applicants" for other experiences, including further work within their labs.

4.2 "Doing" Research

Each student participant discussed the importance of "doing" research, or having the hands-on experience. These "real world" experiences helped them to learn how to do things like collect data, learn how to use new equipment and software as well as how to write up the analysis and present the data findings. ST explained what she hoped to gain from the experience:

> ST: Hopefully, you know, learn and get to feel more like, what the career will actually be like, as opposed to what I'm doing now, which is a lot of studying and not a lot of applying stuff.

ST was hoping to be able to apply what she was learning in class and actually "do" science. SF had similar hopes about her URE:

> SF: I had just hoped to get a feel of what research was like, that was, I think my biggest goal was just, to see what it was like and gain experience in it. I really

> wanted to know what research was actually like because it had always been something I was interested in, but wasn't really sure what took place.

Several of the students talked about the various applications they were learning and how that contributed to their "doing" research. For example, SI, a sophomore in a technology major, shared his experience with coding:

> SI: The research process, like doing the project I did like. You can actually see the difference you're making because you can see the change in a certain line of code that you're looking at, like, the user interface…So you can really see what you're building up to as you go further and further into the project.

SI liked having the hands-on experience of coding and being able to see the changes in the code as he worked through the project. SY talked about how he was able to work on the research project from start to finish:

> SY: I learned how to use SAS a little bit, which was for the coding and data manipulation portion and then I learned how to actually take a large amount of data and formulate the hypotheses and then kind of prove or disprove it and then how to format and present on a poster board mixed in with how to present the poster board.

SY was able to be involved with the entire research process. He not only learned how to manipulate the data, but how to formulate a hypothesis and ultimately present his findings. Several of the students were able to have a lot of independence in their research projects, which typically allowed them to really learn the process and gain confidence in doing research. SF shared this sentiment in her interview:

> SF: I wasn't sure exactly what the level of student involvement was going to be, because I know that like professors pick the topics, but I felt that, and there was another girl who also worked on the project with me, and I feel like together, we kind of lead the whole project and our faculty member was just kind of there to guide us and set us on the right path. So it was really exciting to do something where we can have a lot of control over it.

As SF expressed, having a significant amount of independence in the research

excited her because she was able to control what happened with the research. BT had a very different experience in terms of independence within her research project:

> ST: My big issues were that I had, I didn't have control over how the [data were gathered] I was there to just analyze it. I thought there was some potential problems and biases, but I couldn't do anything about that at that point.

ST expressed her frustrations with how the data were collected because she was not a part of that process. When asked about what she thought the program was lacking she shared, “My study itself, I think wasn’t lacking as much as lacking a challenge and meaning to me.” Because she didn’t feel as though she was a full contributor in the research, she expressed a lack of challenge within the research experience. Although too little independence caused frustration for ST, SL expressed frustration with too much independence:

> SL: I would say that I wish I did have a little more clear guidance. There were no elder members of the research team, so I was left to figure things out with another girl who also just joined. So, that would have been frustrating.

Not having any guidance on how to move forward with the project was overwhelming for SL and her lab partner. She would have preferred more guidance in the research process. SY seemed to have found the perfect balance of guidance and independence within his research project. He shared, “the teachers were good at not being too hands on to where they're just doing the whole thing, but then also giving more of a guidance role so you can still kind of make your way through the process.” Having the faculty member to guide them through the process was very helpful.

ST talked about how she initially felt intimidated and unqualified to do research and during the final presentation as well:

> ST: Early on, I felt like I was maybe not qualified enough. Which I think had less

> to do with the actual program and probably more to do with like personal stuff because the program itself did advertise it was for people with no prior experience… And then a little bit at the end of the presentation. Surely, because I think it was like firsthand nerves of never doing a presentation before. It felt like my topic was lesser than the others. And then, you know, it didn't fit in with the STEM field. But throughout the course of that, that actually changed because a lot of people showed a lot of interest in my topic like people walking by and stuff and talking with me. So, by the end of it, I felt like I did belong, like, which I felt like I belonged all through the middle section. It was just that point before applying and then like around the time before we started the presentation.

ST had to learn how to overcome her initial fears of her ability to do research, which only surpassed after actually doing the research project. Her perception that her project was "lesser than" others made her feel like she did not belong. It was not until she had others recognize her work and validate her belongingness to the STEM community did she regain her sense of belonging. Giving students these URE opportunities can help students to overcome their initial fears of doing research and thus feeling like they belong in STEM.

Several of the faculty talked about what they did to generate independence in students doing the research, but also provided the guidance that they needed as entry-level researchers. FN was an exemplar of this balancing act that faculty tried to do between independence and guidance:

> FN: We try to pick a you know a [project topic] that the student is interested in so that they have that buy in from the first part of the project. And then we try to let them go as much as possible in terms of them guiding the direction that the research takes. We give suggestions, we talk about what's correct statistics, that sort of thing is needed, but I think that piece, at least you know my perception is, that's an important piece and getting them to think, you know, well, "I'm really part of this."

FN explained how the amount of independence and control given to the students really helped students feel a part of the research, as true contributors of the research

project. FJ also expressed the importance of "taking part" and helping students feel like true contributors to science research:

> FJ: And again, just try to get their feet wet. Now, I wouldn't say that the projects that we did last summer, you know, they're not ever going to be published anywhere, I don't think. But they were very good for the students in terms of just thinking about what research should look like and actually getting to take part.

FJ recognized the importance of students being active agents in research and the only way to foster that is to give students real world experience. FA also touched on the realities of doing science and how students learn in the UR STEM program the iterative process of research:

> FA: There's a phrase I use a lot which is "science meets reality". And so, when you're learning about science, you're learning, oh, you know, science, scientists are proposing hypotheses and they set up an experiment to do this and then they get the results. And that's how it's supposed to work. But in reality, it's messier than that. And you realize that you're going, you're constantly revising your hypotheses in your experimental methods.

Doing research helped students to see the "reality" of science and get a first-hand experience in working through the research process. Students enjoyed seeing the process up close and faculty recognized that these experiences helped students to feel a part of science and become true contributors to the science community. Many of the students talked about how the URE helped them to build their confidence in research because they now understand all the different components of the process.

4.3 Career Exploration

Most of the students talked about how UR STEM helped them better explore their career options. This was either through learning more about the different pathways available within their major or through experiences that connected to some of their

interests and hobbies. SF talked about why she chose to apply to the UR STEM program:

> SF: I chose to apply because I was really interested in seeing if research was something that I would like to do because I think it's a good gauge to see if I'd be interested in grad school or not. And I was also interested in this specific project.

SF used the URE as an opportunity to explore research as a career option and to determine if she wanted to pursue graduate school to continue doing more research. Prior to UR STEM, SF was unsure about pursuing graduate school. SZ shared a similar sentiment and how her URE helped her to better understand the different career options within her field of study:

> SZ: I learned more about what specific career I want to go into. I learned, like the difference between different career options. And also, like, I know that usually people will get a masters in [program major] versus just a bachelor's in [program major]. So, I don't know if I would need to get a masters or not in order to go into different careers.

ST also expressed how she hoped the URE would help her with career decisions, "I have to get, I guess the experience to, you know, to know if research was a field, I would want to go into or not." Although the URE did not help her narrow down her career options, it did help her realize what to look for in an URE:

> ST: I think, I went in considering research experiences were all kind of like, I could go into any as long as it was in my field, it would be pretty fulfilling…More specifically I need to look for if I am gathering the data or if I am just going to analyze data that is already there.

The UR STEM experience helped ST to better understand what to look for in a research experience. SI shared a similar experience, where his URE did not help him narrow down his career options, but it did help him determine if he wanted to do more research:

> SI: I would say it has impacted me on like wanting to do more research in the

future and like becoming more experienced. I don't really think it has like, made an impact on me like narrowing down what I want to do in the future or what career path I want to take.

Others shared how the experience helped them to connect to their current interests. SY shared that this was a top component that the program does well:

SY: So, what the program does well is, at least for my situation, it was able to group up the students and teachers in something they could have all kind of have an interesting, an interesting fascination with the project. Because both the teachers were loving [project topic] and then us three [students] were into it.

Being able to do research in an existing interest allowed SY to have a passion or fascination with completing the project. It also allowed him to connect with the faculty and students through this common interest, "we all kind of had the same interests and hobbies, where we could kind of all relate to something and put passion behind the project." SY really liked having the opportunity to connect with others through a similar interest. SF also expressed a similar experience, "Mine was about mixing [program major] and [hobby]. And that was something I was always kind of wondering if I could ever like find an application like that." SF, who was previously considering a non-STEM program prior to starting at NKU, and was excited by the possibility to combine her hobby with her major as a potential career path. Both SY and SF talked about how the URE project helped them to see the "science" behind one of their greatest interests or hobbies. SY shares the following about learning the science behind his hobby:

SY: I'm a big [hobby] fan I like doing analytics or like thinking about how they come up with projections and stuff like that and then being able to kind of make my own type of ways of analyzing the [hobby] and stuff…you're going to need data and stats and regressions and stuff like that.

SY liked learning how the numbers and projections worked within his hobby. It helped him to feel more connected to his program major.

Faculty also discussed how the UR STEM program helped students to further explore their career options. FA talked about how the program helped students determine if they want to pursue research and what type of research:

> FA: One thing that it's really good for in terms of students is, for most of them, it's their first taste of research and they really get to see whether this is something that they want to do. And in my case, it's working on plants in the field. And so, some students have thought that they wanted to do it and they learned that they do not. And, you know, I'm a little sad to see them go. But on the other hand, that's part of what the education is about, it's figuring out what you don't want to do.

FA recognized that the URE helped students not only find what they do want to do, but also what they don't want to do. These are similar to what was shared by some of the students within the study. FM noticed that the impact of her summer project influenced her student's program major decision "Well, she changed her major, I believe, to [project field]." The impact of these research projects has the potential to change the scope of what the students see themselves doing within their STEM careers. FA further discussed how UR STEM impacted students within underrepresented subpopulations:

> FA: Most of the students I've had involved in UR STEM haven't been so certain about research. Or you know, whether it would be a benefit. Frankly I think for many of them, they thought, "Well, this will be more interesting than, you know, being a server at a restaurant for the summer." For some of them, it wasn't their number one priority. They clearly had a little bit of interest in it, otherwise they wouldn't have applied to the program. But, the ones who already know they want to do research, the ones who are, you know, have a drive for that already, those are not typically the students I've seen. Those are the ones who are going to stop by my office and say, "Dr. [FA], I'm interested in doing research, do you have any projects for me?" Now, and those are the ones who I usually do through some kind of external funding mechanism, you know, a grant or something like that. But yeah, UR STEM has been more "There's this research thing sounds kind of interesting, but I don't know". I think that's been the attitude of most of the students who have done it. And I think it's to answer their questions, they either find out they want to do it or they don't want to do it. And if they do want to do it, it really focuses in which direction they want to go. I mean, I had one student who, she worked on [project topic] for the summer and she said, you know,

> "[project topic] are interesting in their own right, but I'm really interested in animals, especially marine mammals" and that's what she's doing now.

FA shared his observation of the types of students who typically participated in his summer research projects through UR STEM. Often, these students were on the fence about research and the project helped them to determine if research was best for them. It also helped them to eliminate what they don't want to do, which narrows their career focus as well.

Although not all students found the research experience to be helpful in narrowing what they might want to do as a career path, many did find that the experience helped them to determine if they wanted to continue to pursue more research experiences. UR STEM appeared to be a guiding post on their career journey that helped them to navigate what types of options are available to them within their STEM major.

4.4 Connecting to Faculty

Each student talked about their interactions with faculty and what those interactions meant to them. Many of the students found the URE as an opportunity to get to know more of the faculty within their department and feel a greater sense of connection and community to their department through the URE. SI talked about how connecting students with faculty was one of the best things the program does well:

> SI: I think just like, giving people like the opportunity to like do research and connect with a research advisor, like someone that's experienced in the field. So, just being able to work with someone with more experience and like getting his feedback is probably very important and like one thing that was done very well during the summer.

SI valued the opportunity to connect with his faculty researcher and learning from his experience. SI also valued the feedback that he received from his faculty mentor.

Several of the students talked about how the UR STEM program not only connected them to their faculty researcher, but with other faculty as well:

> SZ: I feel like it's made me feel like I have a connection with the professor that I worked with and possibly with the faculty that were over UR STEM since it's not like a huge group of people like, they would know people by name. And so, it kind of made me feel more of a part of the [program major] department.

SZ felt that the URE helped her to make connections with multiple faculty within the program. She also felt a greater sense of belongingness to her program major department as well. SM expressed a similar sense of community from the UR STEM experience:

> SM: I think NKU has like a close-knit community like especially in [program major]. So that's where I was working in, so like when we're presenting, fellow professors would come and hear our research and I got to meet and actually talk with a lot of the [program major] professors.

SM was not only able to connect with her faculty researcher, who was within her program major, but with other faculty within her department as well. These connections helped her to feel a better sense of community within the department at NKU. Other students talked about having the opportunity to work and connect with faculty that helped to make them feel more comfortable with the professors. SL talked about how the experience helped her to feel more comfortable with having conversations with her faculty member:

> SL: I've gotten to know my professors, a lot more, which is really nice, like I've been able to comfortably go ask them for favors or to TA, or just for general experiences like that.

UR STEM allowed SL to feel at ease about asking about additional opportunities and experiences with her faculty researcher. SF expressed how knowing more professors within her department helped her to feel more comfortable about taking courses:

> SF: It was also just really nice to meet more professors, because my faculty advisor, I'd never had before in a class. So, it's kind of just nice to know more people in the department. And I know that if I have them in a class, I feel pretty confident that the class will be okay.

For SF, the UR STEM program expanded her network of faculty and helped her to feel more at ease about taking courses within her department. SM shared how these connections and networking benefited her:

> SM: Connecting students with professors and just giving a good introductory experience to research, yeah, that's pretty important. Just having that connection, because I got quite a few letters of recommendation, most definitely really helpful for the future.

The rapport that SM was able to build with her faculty researcher allowed her to obtain letters of recommendations, which aided in her obtaining more research related experiences. Having the opportunity to build a professional network increased SM's ability to expand her experiences. SI talked about how connecting with his faculty advisor improved his confidence in research:

> SI: I feel like it has helped me by like talking to my research advisor and seeing what experience he has and the experience I gained through like doing research. [UR STEM faculty researcher] made me feel like more confident about taking on new tasks and working independently.

SI's interactions with his faculty mentor helped him to gain more confidence in conducting research and working independently. The relationship he built with his faculty researcher influenced his confidence in STEM and his ability to do research.

Not every student who participated in the UR STEM program had positive faculty connections. ST discussed her limited and frustrating interactions she had with her faculty researcher:

> ST: I met with my professor, a couple times in general, it was very, I don't want to

> say limited, limited isn't the word, like, I didn't meet with him often and when I did talk with him it was generally quick and not a lot to say. In my case, it felt almost like I cared to make the data accurate than the professor did, which was also another kind of discouraging thing that it seemed like the professor didn't even particularly care about the topic we were researching.

ST felt that the interactions with her faculty advisor was limited and that the project seemed to lack purpose on meaning to the professor. She expressed feeling discouraged and later expressed not having a sense of belongingness from the experience. Because for these discouraging interactions, she made the following recommendation for the UR STEM program:

> ST: The fact that we couldn't get to talk to the professor's beforehand, before we had to pick the priority of which studies to participate in was detrimental. I think also just more information beforehand. Or some, I guess, some pictures or well maybe not pictures, but just some content. So, we could kind of see what research would be in general would be like. I personally didn't like the experience.

Because of the limited interactions and perceived lack of care and attention to the project, ST did not have a good experience with her UR STEM project. Because of her negative experience, she recommends letting students meet faculty prior to selecting projects for collaboration. SM also alluded to the importance of having prior interactions with faculty before selecting a project. I asked her why it might be intimidating working with a faculty member that she didn't know:

> SM: Just because you don't know their personality and how they are, how they work with students. I think for me, I knew the professor I was going to work with at the time. I already had known as a professor for class. I felt more comfortable like reaching out to him and interviewing with them for that project. But if I went to somebody I didn't know, I would not be as comfortable I think.

SM's and ST's comments suggest that students might have difficulty in pursuing research opportunities because of fears of intimidation and not feeling that they qualify for these experiences. Faculty researcher, FM, confessed a similar sentiment that

empathized with these fears of intimidation:

> FM: You know, but as a freshman, I never would have, you know, tried to get involved in some kind of faculty research, I would have been really, really intimidated. So, just the fact that she applied meant that she had, you know, a lot of confidence and felt like she could do it. But I think that just giving them this opportunity that is not intimidating is something that they feel they can do.

FM suggests that students likely need to feel a sense of confidence or ability to do research. If this initial sense of ability is not present, students might not consider these experiences. This is something that could be even more present for underrepresented students in STEM.

Other faculty also shared their experiences with connecting with students. Many discussed their roles as mentors and how their role served as a mechanism to which students felt connected to their department or the STEM community in general. FL talked about his connections he made with students and how those connections continued beyond the UR STEM program:

> FL: The students that I've worked with certainly have made a connection with me as a faculty member and they've returned throughout the year to ask questions, seek advice about classes and things. So, in terms of establishing a connection with faculty, I think that definitely works.

FL was able to establish a level of trust with his students that they continued to reach out to him for advice. FJ shared a similar experience with trying to establish trust with her students:

> FJ: We have weekly lab meetings where we're all together. You know, the social is important. I think that's when they see you as a person and they're more willing to talk to you about what's going on. You know, hey, I am not a good athlete. So, when they see me fall down on the ice or, you know, miss when we're playing wiffle ball or trip when I'm running around the bases. People laugh, they relax, it breaks down the barriers.

For FJ, creating an environment where students can feel comfortable and see faculty as a person can humanize science and the research experience. As FJ explained, it helped students to become comfortable and it made her appear more approachable. FJ goes on to share:

> FJ: When they do need the private time, you want to build that trust so that they can tell you what's going on because sometimes you have to take on that parental role.

FJ alludes to the fact that faculty are considered mentors and need to build rapport with their students. The UR STEM program helps faculty to make early connections with students and build this rapport. FN viewed his relationship with students as a means to build belongingness for students through research:

> FN: I think in terms of belonging in the department, helping them understand that they can do research. I think we accomplished that when they get to the end of this program. I think they are comfortable working with [co-faculty researcher] and myself.

FN goes on to share about his role as a mentor and building connections with students through research:

> FN: I feel like that everything I do when we're doing a project, we're acting as teachers and mentors. We're trying to let the students take the lead if they can, and most of them have some capability of doing that. But again, this is just what I would do as a teacher. Normally we try to be soft on them, if we have to correct things. We try to be as soft as we can and not harshly criticizing anything, even though it might be completely off the wall. But trying to guide them toward different things that might be better.

For FN, being a faculty mentor is to guide students and not be too harsh. He tries to provide a level of independence for students, but “corrects” them by having conversations about other alternative solutions. Many of the faculty recognize this need to guide students and to help them feel connected to the research as well as to the faculty

researcher.

4.5 Building Relationships with Peers

Several of the students who were able to work with other students on their projects talked about building relationships with a fellow lab partner or others within the program labs. This team comradery strengthened some of the students teambuilding skills and others expressed a greater sense of connection with their department because of the relationship they were able to cultivate with other students. SZ shared how the project influenced her ability to work with her fellow peers:

> SZ: I feel like it helped me be able to work with teammates on a project. Like, I obviously have done that in school, but with the research project, it was more of a serious project. It wasn't just trying to get a good grade in the class. It was actually trying to put our thoughts all together to make a cohesive paper.

SZ share her perception of the seriousness of the research project, which influenced her to work cohesively with her lab mates to complete the research. SF talked about how her lab mate helped her with correcting technical issues:

> SF: You can't exactly figure out why it doesn't work and I think the best way that I dealt with that was just working with the other member that was on the project, like just kind of like collaborating. So, we would like talk back and forth and like we'd get on Zoom meetings like ourselves, and like work on things together. And that was really helpful.

SF's statement suggests a level of investment within the project and her willingness to collaborate with her lab partner to correct what was wrong with the equipment. She was able to build a bond with her research partner, who, together, figured out how to repair the technical issues. SL expressed a level of bonding with her lab partners as well:

> SL: Three large groups shared a lab, so I got to know a bunch of people within the department. And funny enough, we all, even though some of them have graduated at this point, we all continue to meet online and we do things like movie nights and we do Dungeons and Dragons sessions and stuff like that.

For SL, UR STEM introduced her to several students within her department. She and her lab mates made such a connection, that they continued their relationship beyond the UR STEM project. The program allowed her to foster new friendships and have a stronger sense of community and belongingness within her program major. SM shared a similar sentiment:

> SM: There's another student who started with me on the same project. So, we got really close working together and we are still friends. So that was a good experience.

SM was able to continue her friendship with her lab partner as well. Similar to the faculty connections, relationships with peers also expanded beyond the research project and helped to build a sense of community for participants.

Two of the faculty researchers also talked about the connections built between peers and how they orchestrated the lab dynamics to foster these relationships. FJ partners the UR STEM students with experienced lab students to help them learn the proper procedures and how to appropriately use the equipment. She describes the peer to peer mentoring environment that she tries to create:

> FJ: I think when you have that dynamic where you're continually bringing in students, it's the peer mentoring, we often pair students, I don't like them working solo in the lab for both safety reasons and for lab dynamics. I call it "near peer mentoring," it's very effective. So, they hear from the students that are doing more and that motivates them.

The "near peer" mentoring that FJ tries to establish within the lab helped students to learn from upper level students and to have a model of what could be if they chose to

continue to pursue research within FJ's lab. FJ continues to speak about how the near peer mentoring model also provided the entry level UR STEM students mentors to help them with classwork as well:

> FJ: Letting them know that you are not the only one to struggle in organic, make sure you know we have good support in terms of tutoring in terms of our STEM ambassadors. And again, this is where knowing a senior student in the lab that survived it is beneficial to them. So often they internalize that "it's only me, I'm the one who's failing" and it's like, this is tough for all of us.

FJ recognizes that having senior students interacting with entry-level students can help them to realize that they are not alone. This is something that only a fellow student can provide and FJ tries to foster this type of communal dynamic so that students don't feel alone and that they are all in it together. FA also recognizes the importance of having students working together in the lab:

> FA: They've always worked with others. So definitely with me but, it's always been with one other student. And so, you know, try to build up a sense of lab camaraderie through that, that you're not just working by yourself.

FA understands that having UR STEM students working with other students in the lab can build camaraderie and a sense of community within the lab. FA also talked about the peer dynamics established by the UR STEM program:

> FA: They're also engaged in a course, the UR STEM course. And there's a number of activities that they're involved in in there. And so, of course, part of that is also so that they don't feel necessarily isolated in one lab, but they realize, "oh, there are other students who are working with other people who are dealing with some of the same rewards and challenges that I am just in a different setting."

FA shares that having the UR STEM course and activities students are afforded the opportunity to communicate and connect with other students in different projects. As the students interact, they hear about the challenges that they encounter and this fosters a

sense of community as well. It gives them a sense that they are not alone.

Peer connections appear to influence student sense of community just as much as faculty connections. These dynamics help students to feel that they are not alone, specifically when they are met with challenges. UR STEM students are able to receive mentoring from students and create a bond with students. These bonds appear to also help students to feel a sense of belongingness to STEM, which influences their sense of science identity.

4.6 Understanding Science Nomenclature

Several of the students discussed the process of learning science nomenclature throughout the research experience. Most of these overwhelming encounters occurred early within the project as many of the students had to read research articles related to their project. These readings were often filled with terminology the early researchers were not yet familiar. SZ talked about her experiences with trying to understand the technical language within her project:

> SZ: I think towards the beginning, when I was reading through research papers or like reading information [he] wanted us to read, maybe I wasn't understanding it 100%. Especially because I'm not really in the field of [project topic], I got a little discouraged. I wasn't like up to the standard that they needed me to be. But like after having a few Zoom calls and like understanding that it's just a learning process, like the other people I was working with we're kind of at the same level of, you know, just trying to understand it. You don't understand all of it or know what you're doing completely, just like, you know, our professor was helping us through the steps.

SZ felt discouraged by the technical language and terminology of the project that she didn't feel "up to standard". This suggests that navigating the nomenclature of science can have an impact on a student's sense of science identity and feeling that they

belong in STEM. But for SZ, she had the guidance of her faculty researcher to help her learn the technical acumen and gain her confidence in doing research:

> SZ: Then I feel like whenever we had those meetings, like after we had read all the material we needed to, he was helping us to summarize information more and kind of guiding us in the direction of where we might want to go with our project. So, I think I started to kind of understand the direction we were going. So then like after talking about it as a group, it helped a lot.

SZ's professor was able to help her to summarize and digest the information from the research articles she read. His guidance helped her to regain her confidence and feel a part of the STEM community. SM shared a similar experience where she wasn't sure where to search for current literature on her research topic as an entry level researcher:

> SM: Being as I'm still inexperienced in chemistry, it was difficult for me to find websites such as the American Chemical Society journals and stuff like that. Although towards the end of the project, he actually pointed those out and help me figure out how to search through them.

Not knowing how to navigate the literature review process, SM expressed that this influenced her sense of belonging as her experience as a novice researcher made her feel as though she did not belong in STEM. Her faculty researcher was able to help point out sources for her to use. Having a faculty mentor to guide students through the science nomenclature can help students to regain confidence and a sense of belonging.

Not all students expressed a negative experience with initially learning the literature and nomenclature of their project topic. SI expressed that the initial readings he was assigned helped him to better understand the project and the process of the research:

> SI: So before we started, he gave me like a research paper to read. I had information about the project and like a bit of like background information before we actually went into like creating the project…the reading was like actually very helpful because it was a research paper like very similar research. So, it pretty much explained to me how we're going to be like doing stuff and how the project

should look at the end.

SI used the literature to help him better understand the project. It served as a process map for the research project and he was able to better visualize the end product. Science discourse can often be difficult for novice researchers to navigate. Having an experienced researcher and mentor present to help guide early researchers can help dissipate fears of inadequacy and lack of confidence.

Three of the faculty researchers discussed working with students to better understand the science discourse of the research articles reviewed and navigating the science culture. FM spoke to her student researcher upfront about the dense language and terminology that she would encounter in the assigned readings:

> FM: I was like, “Oh, there's going to be a lot of things here in these peer reviewed articles that you're not going to feel comfortable with”, you know, “There's going to be things here you're going to miss and that's okay.” So, I think she got to build some confidence, just in reading you know, peer reviewed articles.

FM wanted to make sure that her student researcher understood that she wasn’t expected to know and understand everything that was being discussed in the readings. To help her students better understand the semantics of the project, FJ assigned video webinars:

> FJ: So, it might be a paper, because they were new to [project subject]and we have one and only one [project subject] class in our curriculum. There is a lovely site called [subject website] and it's broken down in modules. So, I would assign one student to find out about this and then present, for another one, find out about this and present. And then we would discuss how that related to what we were doing in the lab. So, they were getting a mini lesson in the principle of [project subject]. And then we will know that now you understand why we're using that [specimen], because it has a defect in that enzyme, and that means they're going to be more susceptible. Well, that's our hypothesis. So they were able to tie it together. Where in the past we would be more focused on what we were doing in the lab without thinking about why we were doing it.

FJ recognized that her students needed the foundational knowledge to better understand the research project and why they were conducting the study in a certain way FL talked more about understanding the research culture and preparing students for this culture, which they would encounter in graduate school:

> FL: I got to do a lot more talking about professional level things, the cultures of academia, all three of them expressed an interest in grad school coming into the project. And so, I got to really just talk to them more about the culture of academia and the reality of grad school.

FL wanted to prepare his students for the culture of academia as he believed that this subculture would be different than the undergraduate subculture the students were currently experiencing. Similar to the other faculty, FL acted as a guiding post to help students better understand the culture and discourse of science and academia. These faculty were aware of these potential hurdles and obstacles and added safeguards to help the students along the way.

4.7 Who can be a scientist?

Each student was posed the questions; “Describe a scientist” and “Do you consider yourself a scientist?” These questions were asked to better understand the student’s sense of science identity. Students responded to both questions in varying ways. One typical response for “describe a scientist” was a rigid description of a scientist. SZ’s definition is an exemplar of this:

> SZ: In my mind, I usually would think of somebody who already has a degree of some sort that would qualify them to like work in a lab or to understand information they're working with. And also, somebody who probably has done more than one research project and understands how to work at a lab and get results.

SZ’s definition includes qualifiers such as a degree and completing more than just

one research project. SY had a similar definition of a scientist:

> SY: A scientist is someone who is very highly educated, who has gone to a postgraduate education, who is trying to, I'd say, analyze and fix some of the problems of society, whether it be medicine, doctors, and then like economists.

For SY these qualifiers include a postgraduate degree and working in a specific occupation such as a doctor or an economist. Because of these narrow definitions of a scientist, SZ and SY felt unqualified to be called a scientist:

> SZ: I guess like honestly, I don't. I want to feel like I am…I don't have a lot of knowledge in my field yet, since I am still like a sophomore, even though I do have a research project under that I've done before. Like, I feel like that's just the beginning steps.

SZ expresses an internal struggle with wanting to qualify to be called a scientist, but her current perception of a scientist nullifies her desire to be seen as a scientist. Although she recognized that the "doing" of science within her UR STEM project helped her to get closer to this identity, she didn't quite meet the standard.

Other students also shared a similar dissonance with wanting to be a scientist and not meeting the internal "bar" or definition of a scientist. For SF and ST, they described a scientist in broad, more inclusive terms:

> SF: I describe a scientist as someone who poses a question or has some kind of goal and has like a set process to achieve it. So, when I think of a scientist, I don't really just think of someone who works in like, actually, the sciences. I think that it could be like social science or it could be math. Also, it applies in any case where you have some kind of topic you want to know more about where you want to answer in some way. And so, you seek out the answer whether that's like conducting experiments or just like observing.
>
> ST: In the broad sense of just looking into stuff. And simply, you know, trying to gather information from it, with the goal in mind that you are trying to figure out what the truth of the matter is, or trying to find as close to the truth as you can and just compile information and then kind of, professionally doing it to a certain set of standards.

These broader definitions of a scientists allowed a myriad of individuals to be considered scientists, including, by their definition, students who have completed a URE. However, when asked if they perceived themselves as a scientist, both expressed an internal conflict of being able to do so:

> SF: Can kind of be an answer? Because I think, yes, I just, I feel like I am in a way like through our research [in UR STEM]. But I also feel like I'm working to be a scientist by going to college. Like, I think that's like the end goal of being in college.
>
> ST: I suppose, technically, by the definition I gave, I should, however, I cannot, I don't feel comfortable. Like, I feel not qualified enough to identify as a scientist, even though that is not something I would apply to in my definition. Which I guess is because, to me, a scientist is also, it feels like there has to be some level of expertise. Which probably isn't a fair definition for that. But I think it's one that's just kind of ingrained in me that I can't really get out.

SF and ST acknowledged that their definition would qualify them to be scientists, but they both refused to allow themselves to be placed in this category. Both SF and ST placed additional qualifiers to their definition in order to disqualify themselves as scientists and thus attempted to resolve the internal dissonance they have created. ST confesses that her inability to claim the title of a scientist has been "ingrained" in her. She elaborates on this ingrained definition:

> ST: I think, in general, there's this imagery of scientists being like people with doctorates or degrees or just whenever you think of scientists they're supposed to be, you know, exceptionally smart or qualified. I guess, I don't want to say, a little bit of a glorified term. It's kind of like when people talk about scientists, they mean the people that are accomplishing great things with their science, rather than just, you know, scientists that are say doing something very local that doesn't have huge effects, which probably also comes from just in general, growing up with media where the scientist characters are, you know, people have degrees and again doing you know grand experiments.

ST shared how media has impacted her definition of a scientist and thus it influenced her ability to perceive herself as a scientist. The stigmas of a scientist

influenced her science identity, even after she gained research experience, which was her initial qualifier to be called a scientist. Several faculty discussed their own personal observations of their students having this internal conflict of accepting the title of scientist FL shared how his students did not want to fully internalize the science identity:

> FL: One of the students sent me their end of semester report and they still sort of referred to themselves as a future [subject professional] and I'm like "you just did original research that we're going to like type up and publish" some people would argue that you like "check box, you're a [subject professional]."

FL shared how he had to explicitly validate a student's science identity by reminding her that she conducted original research and published her work. FL goes on to share how he noticed the high standards his students hold themselves to in order to be considered a scientist and how he positions himself in influencing their preconceived notions:

> FL: I think that how students define sort of like "the bar" for being a scientist is different than where we would place the bar. And I don't know, maybe this is just my fault. Right? And I'm not doing a good enough job like explaining to the students that like "you just produced original content" and stuff like that. "You're doing the science" or for me the [project topic] right? And like that's what it takes to be considered. I don't know, maybe I just need to like praise it up more like "no, no, like you're in the club!" Maybe I just need to be more explicit. But I think the students that have walked away from my [research project], they're definitely now eligible to be members of the club, but they feel not fully in yet and I don't know if that's because like all of their goals? Maybe not all, but like my students like, had the interest in lots of research and grad school and you know like you look at somebody's CV and you forget the fact that, like there are years' worth of work in there. And that's not like the snapshot of what they were when they were in undergrad.

FL shared how his students often place "the bar" higher than faculty would in terms of qualifying to be a scientist or researcher. FL continues to share that he might not be doing all that he can to help students overcome these stigmas of scientists and offers the self-recommendation to praise students more in their accomplishments. He alludes

that his validation of their work might help students increase their sense of science identity. FL believed students typically feel that they have to be much more accomplished in order to be scientists. Students within this study expressed a similar belief that they needed more experience to be a scientist, although the UR STEM experience has helped them get closer to achieving the scientist title:

> ST: Definitely after this, I feel like closer to being a scientist. It felt like I went from just being a student to being like something between student and kind of professional scientist, professional [program major], whatever. It really feels like I'm just a lot more qualified via again this. And it feels like if I had graduated without this, I would not felt quite as much like a true scientist. So, it definitely felt like a necessary experience to identifying as the scientists for me.
>
> SI: I wouldn't. Mainly because I don't think I have like the needed experience and skills at the moment to be able to like fully conduct research and find a solution to a problem given to me.
>
> SF: I think it's just helped me get further along on that journey and like getting some more skills in a new topic.

These students expressed how UR STEM has helped them along their "journey" to becoming scientists. They hold a greater sense of science identity after the URE, but believe they still have more skills and education to acquire in order to be full scientists.

Several of the faculty talked about the activities they engaged their students in to build their science identity. For example, FJ created lab memorabilia to build both lab sense of community and science identity for her students. FN shared that he cultivated science identity by encouraging student independence and input on the research project:

> FN: I think that it benefits them too, you know, by working directly with the two of us, working directly with faculty mentors that we're sending a message to them, you know, "Yeah, we have thoughts on your project, but you have thoughts too, and those thoughts are important."

FN recognized the importance of engaging students in the research process and

the “doing” of research can improve student sense of science identity. FA shares a similar sentiment:

> FA: Once you get underway and especially once you get some preliminary data and students realize that that's part of the process, and they're involved in that as well when they do this. And I think that takes in a way, it takes a scientist off of this pedestal where you're saying, “I'm gonna have a hard time ever getting up there” and it brings it down and you realize “oh okay, science is about solving lots and lots of problems, and I may be able to do that.” And so, yeah, I think that realizing that learning about that does increase their sense of identity as a scientist.

Similar to FN, FA uses the “doing” of research and engaging students in the research process to help redefine student perception of a scientist and “demystifies” the research process. FA expresses that students begin to realize that anyone can do research. He continues to elaborate on the idea of research being an activity that anyone can do:

> FA: I try to be a down to earth person and just say, “Okay, yes, we've had these ideas or running into some problems. What's the problem? What's the solution?” Or, you know, “what are some possible solutions? Let's try and think those through what would happen if we went with plan A, or we went with Plan B? Where do we think that would go?” So, engaging a student in that, first of all, it demystifies the whole thing. That somehow, I've got this, you know, different intellect, because I'm a white guy who's the stereotype of what a scientist is. It just becomes an activity that everybody does. And once you realize, “oh, this is an activity that everybody does.” If you're a person who doesn't have my identity, you can say, “well, I can do that too.” It's just this is what the process is like, and it's a process that's accessible to everyone.

FA talked about eliminating the stigmas and stereotypes of who can do research by engaging students within UR STEM, who are typically underrepresented students in STEM, in the research process and proving to them that they are capable of doing science. Similar to FN and FL, he views engaging students in the research process and his role as an experienced researcher as validating students in being scientists and influencing their science identity. Independence in the research process empowers

students to have a greater sense of identity in science as well.

4.8 STEM Persistence: Barriers and Solutions to URE Participation

There were a couple of themes found within the data that were exclusive to the faculty researchers. One of these themes involved the barriers and solutions to STEM persistence and URE participation. Three of the five faculty researchers discussed the barriers they have witnessed that have often prevented students from pursuing a URE opportunity and can some that prevent STEM persistence. FL talked about how the timing of when the UR STEM application process occurred could be a potential barrier for some students who might be considering a URE:

> FL: I guess I always feel like the process starts earlier than a lot of my students who aren't the go getters would be looking. I don't know that you can expedite the pace of the project at all, but I don't know that the students who maybe aren't the go getters are already like looking at the potential of research. I think about the process starting like in December or January when I submit topics. I can't remember when it starts for students, is it February that they're like applying? Whatever it is, that always feels very early in the semester to me and to a certain extent, I don't know that all of the students are thinking about summer plans at that point. And I understand most competitive summer things, it's October of application or like early December or January application deadlines. So, February is kind of late, but I don't know that our students are looking that early or at least the demographic of the maybe struggling, maybe not fully engaged, but want to engage more. I don't know that they're looking that early.

FL alludes to the point that some of his struggling students or students who might be on the fence about research might not consider searching for summer opportunities in February. FL goes on to discuss the barrier of communicating the URE program to a broader audience:

> FL: I also don't know if they've heard about it. I think that there's a great job done with students who are already in sort of these supportive programs. Making sure that they're aware of all of these opportunities, but I don't know that students on

> the whole are aware or like students that aren't in those programs are super aware so I hate saying like PR and marketing campaigns, because those are hard to do effectively as well because we already get so many emails that you just delete. But that could maybe help. And maybe, I don't know, but like, we have a list of these opportunities that academic advisors could target to students at the beginning of spring semester or when they meet in the fall with their first-year students.

FL suggests that there is an audience of students who are likely not aware of these experiences. He suggests partnering with advisors to widely communicate the UR STEM program to all first-year students. Reaching a broader audience could potentially diversify the application pool and the student participants of UR STEM. FL also talked about many life challenges that students are balancing that could prevent them from participating in a summer research program:

> FL: There are so many things that I think our students are going through in their lives and what they're managing and so many of them finances is such a thing that, you know, when they think about working over the summer, they're definitely thinking job and full time. And anything else is conflicting, it is a potential conflict that stands in the way.

FL reflects on the types of students he typically sees entering his program discipline and how they are often pressured to find summer jobs that pay well and offer full-time hours. These types of pressures make it difficult for underrepresented students, specifically those who are economically disadvantaged, to seek part-time research experiences. FJ acknowledged this as well for her students within her discipline and how adequate funding could potentially alleviate this barrier:

> FJ: And not every faculty member has funding and these students need money. That's one of the at risk coming from an underserved area. We have not only the urban Cincinnati population, but we have rural counties that have a high poverty rate. So, both of these are underserved and very likely to then go off and work some crazy warehouse job at Amazon, which pays more than week we are allowed to pay. And you know, we see this in our classes all the time. So yeah, it would be great if there were funding for these all year long. Because I frequently

> hear from students “I have to leave now to get to my job”, “but I paying you too”, “but my job when it's off campus has a higher priority because it has a higher pay rate.”

FJ addresses the pressures that students often feel to take higher paying non-experiential learning jobs in order to meet family obligations. She shares that some students are working both the URE and another non-STEM related job in order to meet financial needs and these can often be in conflict with one another. She goes on to discuss how these conflicting priorities can potentially lead to students leaving college:

> FJ: I certainly have had students who did not give up the other job and I did my best to schedule around it. We have this shared Google Calendar and they'll pop in when their work hours are so I can see when they're working way too much. And frequently, this is what I hear that, you know, “I can make this much and I get benefits”. Now, sometimes it works out well. So, what I try and do is encourage them to stay long enough to get experience, we have Cincinnati Children’s right across the river. And so, I've had students then basically get their full-time job before they graduate so they transition and then they end up working in a research lab there. They get some tuition remission benefits and they're more financially secure and they're building skills. So, in my best-case scenario that's where they end up, but there are some that have to drop out for a semester or two. I've had students leave and come back. So that is not uncommon in this area because they're commuter students.

FJ tries to urge her students to stay within her lab long enough to gain skills that would allow them to pursue a full-time position within an external research lab. But, as FJ mentioned, the financial burden and strain on some of the students within her department become too great that they have to drop out of college for a semester or so. FJ believes this is due to the large number of commuter students at the university, who often grapple with family and work obligations. FA discussed the commuting challenge and how it influences his conversations with student applicants to the interviewing process:

> FA: Well in my case, you know, is transportation to the fields site going to be an issue. I have had students who don't drive or don't have their own car. And that doesn't knock them out of the running as far as I'm concerned, I'm more

concerned with, “Okay, can we work something out?” so that they can get transportation.

For FA, he tries to avoid transportation as a potential barrier for students by discussing options that students can consider in order to find ways to get to the field site. FA understands the need to be flexible in order to meet the students’ needs and affords them the opportunity to participate in an experiential learning activity. FJ also talks about how she tries to be flexible in her lab when students are facing conflicting obligations:

> FJ: They may have a family matter that pulls them away. There's a phenomenon I call the second mama syndrome. The oldest sister is often responsible for her younger brother. This is a scenario that I think has come up as often as the financial, that they are expected to leave the lab and go home. I've heard these conversations one sided when they pick up their cell phone and they’re, “but I'm but I'm” [individual on the phone says] “no, no, you need to come now.” So, we try to be understanding and flexible, but these are the pressures that these students face. And they are obstacles that a more traditional student does not face.

Similar to FA, FJ tries to afford flexibility to students who need to balance school and family obligations. FJ recognizes that these are challenges that are often unique to post-traditional students, or students who commute to college and have family responsibilities. Another way that FJ tries to encourage students to persist and pursue UREs is through what she calls the “permission to say no”:

> FJ: So, one of the things is permission to say no. And that's where I tell them, you know, you put your schedule up there of your needs during the academic year. Some of them do take summer classes, by the way. And that's something we discussed, you need to study for that chemistry exam? You block out four hours and I'm not going to schedule you. So, making sure that they understand the importance of the academics.

Again, FJ creates flexibility within the URE that allows students to meet the varying demands that they face, including studying for an exam. She recognizes the value in communicating to her students that their academic performance is important and

supported within her research lab.

4.9 URE Benefits and Barriers for Faculty

Most of the faculty discussed benefits and barriers to participating in undergraduate research for faculty. For example, FM was attracted to participate in the UR STEM program because of its small time commitment:

> FM: Usually I ignore emails that are about doing research with students because you know that sounds like something that a tenure track professor is usually getting involved in. And this one just kind of, you know, jumped out at me because it was kind of a smaller thing and it wasn't nearly as involved as I always imagined research projects with students would be. I guess I'm thinking back to my own graduate school experience which you know definitely wouldn't be anything like that.

FM appreciated that the time commitment wasn't as involved as something that would be expected in a graduate research project. She perceived that the URE program would be manageable and something that she could do as a non-tenured track professor. FA stated that he used the projects as a means to recruit students for his upper division courses:

> FA: It is a recruitment tool for me for my upper division courses. You know, related to [project topic] that often students who do research take. I see them in my courses later too.

FA uses the summer research program as a means to expose students to topics related to his upper division courses. Often students who have conducted research with FA would later enrolled in his related upper division courses. FL expressed that the program fostered a sense of community for faculty as well:

> FL: The conversations that we have among faculty about perhaps teaming up and co advising programs I definitely think contributes to a sense of community, both among the department but then also, when the students are doing the projects a

community there as well.

By co-advising a URE project, FL explained that these shared research projects often created a sense of community not only for the students but among the department faculty as well. FM stated that participating in the UR STEM program increased her confidence in her ability to manage and advise an undergraduate research project:

> FM: And I think it was helpful for me, too, because I've never guided a student in research before, so I wouldn't have if it wasn't for this program. So, it definitely helped me to feel like, “oh, okay, well maybe I can do this. Sounds like a pretty good program. Sounds like a good opportunity.” You know, I do have a little project in my mind. I bet I can get a student to help me with it. It's involving [project topic] so I'm sure I'm going to have students apply. You know, I was afraid like, well, “is my research too lame?” nobody wouldn't want to apply. But yeah, that wasn't a problem.

Although FM was hesitant that students might not be interested in her project, she was hopeful and was happy to have the opportunity to submit a project to work with students in research. In terms of being a tenured-track faculty member, FJ felt that the UR STEM program gave her the opportunity to build her tenure portfolio:

> FJ: I'll just admit to being slightly selfish that I wanted documentation that I was a successful mentor. That is absolutely valued by the department and written into our guidelines at both the departmental level and the college level. So the remarks that come back, this is considered one of the highest forms of teaching is mentoring. And that's why I came here to mentor undergraduate researchers, I wanted to teach. But I didn't want to give up the research lab. So yes, they want to know that you're willing to do it and that you can do it successfully.

FJ had a drive to do undergraduate research and being recognized for participating in UREs is something that is valued within the tenured process. However, FJ goes on to discuss how these experiences should be valued beyond the tenure process:

> FJ: I was concerned about the administration. We have our university mission and Success by Design, and we put these things in there. But if they're not putting financial resources in it, I often say during the academic year when students sign

> up for credit, “I get neither a penny of compensation or a second of reassigned time for mentoring undergraduates who are doing research credit.” And they [i.e. administration] used to tell us what you could bank. “Once you got 30 hours we’ll give you a course release.” And they never came through on that promise and now they're making it even more difficult.

According to FJ, the rewarding structured beyond the tenure process did not support faculty participating in undergraduate research. Faculty did not receive release time nor additional compensation for advising an undergraduate research project. FJ suggests that not aligning the course load structures to account for research advising, these circumstances will make it difficult for NKU to achieve their STEM objectives and degree attainment goals. FL also talked about how research with undergraduate students was perceived within his department:

> FL: This program with doing UR STEM, we're very much from a sort of professional scholastic standpoint and from a tenured standpoint, like is it is viewed more as a teaching endeavor. You advise this undergrad project and it wouldn't necessarily count as scholarship, unless I got, a publication or something out of it. And given just sort of the disciplinary nature like it's probably not a guarantee that you're going to get something publishable out of working with these students. Just for the amount of time and extra that it takes and so I guess like $400 or whatever the faculty stipend is. I think that there's a calculation in terms of do we do it, do we not, is it really worth the amount of time and getting things out of it.

Similar to FJ, FL addressed how the current financial structure of the university can be a barrier to faculty determining if they should participate in the program. Currently, there is a perception within FL’s department that faculty are not rewarded to participate in these types of programs.

Another obstacle to URE and specifically UR STEM, discussed by FJ concerns the recruiting efforts of faculty and some of the barriers faculty face in their willingness to participate in the program:

> FJ: You want to survive, you want your job so, you're more likely to take the student with the 3.75 GPA, that is going to be dependable and can balance and doesn't have these additional obstacles to overcome. You mean well, but I think there are going to be faculty that are going to be reluctant to do that, they're going to limit the number where the need is great. So, we're not going to get to our goals if we don't increase the number of faculty who can support these students year-round.

FJ addresses the demands that faculty face to do well and how some might be reluctant to participate in a program like UR STEM, where the objective is to use early entering students for research. She states that the university cannot not meet their STEM goals if they cannot find more faculty to commit to helping underrepresented students in STEM in year-round UREs. FJ goes on to explain how the current university structure does not value undergraduate research:

> FJ: They are providing zero reassigned time and zero compensation [for undergraduate research]. So that's an upper administration issue. We've tried to say that research faculty need a nine-hour load, not a 12-hour load, we should not have the same teaching loads as our full-time lecturers who do not have research and mentoring responsibilities. And I've seen it kill some of our junior faculty who have not made it to tenure, because they're teaching loads were ridiculous. But it's not at the departmental level. And I would say it's not even at the college level, although obviously the deans control the ultimate budget.

FJ explains why it is pertinent to create reward structures that recognize research with undergraduate students. She states that these structures currently hinder NKU from reaching their STEM goals. However, she believes there are some things that the UR STEM program can do to help engage more faculty in the program:

> FJ: I think it would be great if the mentors got together and talked about what did and didn't work. And I say that because I also belong to the society of [project subject] and we realized that the summer internship programs don't always support students as well as they could. So, we're actually planning a panel discussion from large labs, small labs, big-small institutions at our meeting next March, where we are going to talk about what worked well with underrepresented students and trying to enlighten people on how to support them more effectively,

one size never fits all.

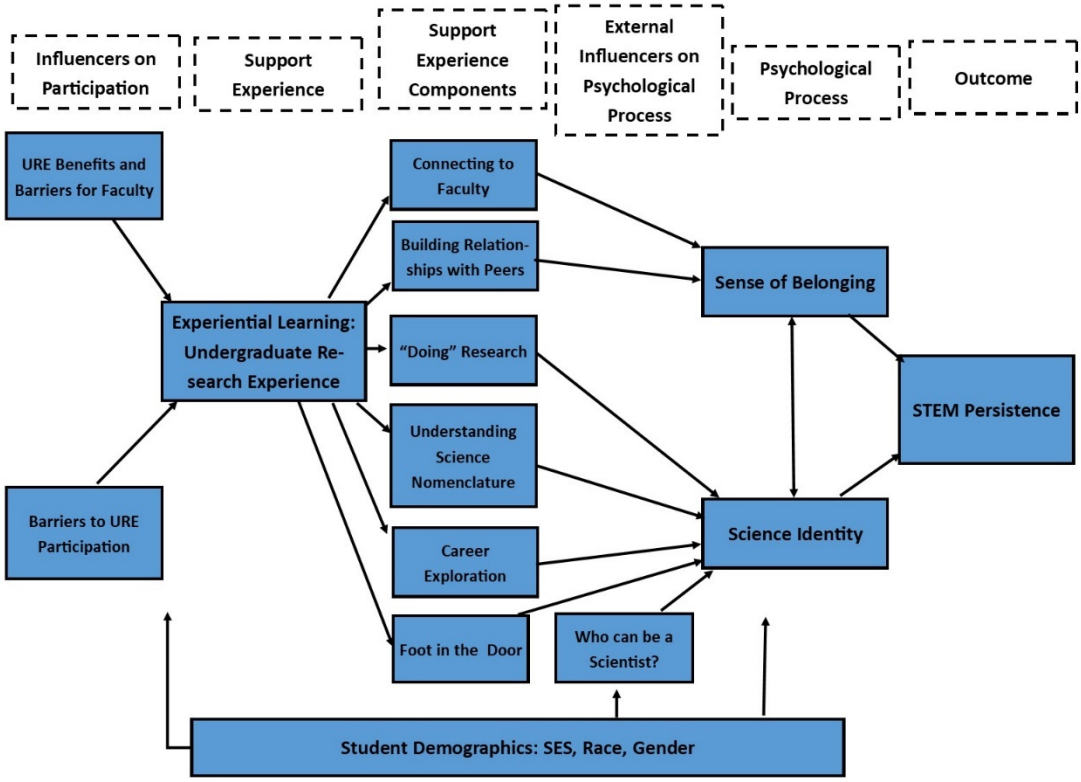
FJ recognizes the need for faculty researchers to come together to learn from each other and find out what is working and what is not working. These types of FAQ seminars could be beneficial for novice faculty researchers and helping them to have a successful research project experiences and thus likely positive influence on STEM persistence.

4.10 URE Process Model

Both students and faculty discussed components, experiences, and perceptions that they experienced during the summer undergraduate project. These factors contribute to science identity and sense of belonging, which then influence STEM persistence. I propose a process model that outlines how each of the components found within this research influence STEM persistence. The faculty and student barriers discussed specifically by faculty are external influencers on who can or will participate in undergraduate research. Students from underrepresented demographic backgrounds might be more likely to be negatively impacted by these barriers, such as economically disadvantaged students who need to work full-time and thus unable to participate in a summer research project. Once students are able to move beyond the external barriers of participation, they can then engage in the experiential learning activity of undergraduate research. URE then offers several support components: career exploration, "doing" research, foot in the door opportunities, connecting to faculty, building relationships with peers, and understanding science nomenclature. These components influence the psychosocial factors of science identity and sense of belonging. There are other external psychological factors that impact science identity as well. I pose these as the internal

question, “who can be a scientist?”. Even throughout the URE, students still question themselves as to whether they qualify to be a scientist. This internal questioning, student demographics, as well as the support components influence science identity and sense of belonging, which then influence STEM persistence. This URE process model is outlined in figure 4.1.

Figure 4.1 URE Process Model



CHAPTER 5. DISCUSSION

Establishing experiential learning activities at the institutional level is no small feat. Colleges and universities first need to know which key aspects and features of existing experiential learning programs make them successful. Although researchers have

called for investigation into how institutions can up-scale these types of practices at the university-level, there is little research on how universities are successfully implementing these institution-wide on their campuses (Hurtado et al., 2011; Museus, Palmer, Davis, & Maramba, 2011). The current research uses a case study analysis to investigate what strategies and practices cultivate belongingness and science identity among underrepresented students within a successful summer research program. Two research questions guided the present study (a) how has the participation in a summer research program influenced student persistence in STEM? (b)how have, if at all, the program aided student science identity and sense of belonging for underrepresented students? My study provides support that the summer research program, UR STEM, fosters student science identity and sense of belonging for underrepresented students in STEM. As suggested by Hurtado et al. (2011) and Chemers et al. (2011), experiential learning activities, such as UREs, cultivate a sense of science identity and community for underrepresented students in STEM.

5.1 Foot in the Door

Students talked about how they viewed the URE as a "foot in the door" experience that allowed them to gain early access to research skills and make networking connections with faculty. Having the opportunity to conduct research so early within their education careers helped students to strengthen their resumes and apply for additional research experiences and internships in the future. There are a number of studies that support these early engagements with research that can help increase STEM persistence (Chemers et al., 2011; Espinosa, 2011; Ghee et al., 2016). Students reported that these early research interactions helped them to build science community and sense of identity.

These findings mirror other previous research on URE and their influences on science identity and sense of belonging (Chemers et al., 2011; Hurtado et al., 2011; Lane 2016). The current study also found that these research experiences gave students a sense of confidence in their ability to do research and thus contributed to their perception of belonging to the science community. Faculty also discussed how affording students early experiences in research were contributors to student science identity and sense of belonging. Many of the faculty discussed their reasons for participating in such programs like UR STEM are because of the programs mission to provide underrepresented students early engagement with research, a gap they recognize is often overlooked in other research programs.

5.2 "Doing" Research

Not only did students appreciate access to early research opportunities, they enjoyed being able to "see behind the scenes" of research. Providing students active roles within the research process attributed to their sense of science identity and belongingness to the STEM community. This is similar to Hurtado and her colleagues (2011) findings where students who were engaged in research with faculty communicated a sense of belonging and science identity. Lane (2016) also found that programs that offered students the opportunities to have hands-on experience were able to influence science identity and belongingness. This study not only furthers previous work in this area, but found that their needs to be a balance in the amount of independence students are given within a research project. For example, one student expressed not having enough independence in the research process and how she wanted more input on how the data were collected. And another student stated that she felt overwhelmed at times by the

amount of independence allotted to her in the research study. Both of these experiences caused doubt and frustration for these students, which influenced their science identity as well. Furthermore, one faculty researcher explained how these interactive experiences allowed them to see the "messiness of science", unlike the controlled environments of courses and many science labs. Students learn how to problem-solve and be critical thinkers within the research project.

5.3 Career Exploration

The current study found that experiential learning opportunities that allow students to explore their career options helped students to attain a better sense of what prospects are available to them within their discipline of study. Several students talked about how the URE helped them to envision how they could pair their hobbies and interests with their program major as potential career paths. These results suggest that experiential learning opportunities that are able to combine students' interests with their STEM disciplines could be a strategy to ensure STEM persistence. This can help students "see themselves" as scientist and improve their science identity, a typical result of UREs (Lane, 2016; Leggett-Robinson et al., 2015). Faculty in this study recognize the importance for students to have the opportunity to explore different avenues of STEM and try to propose projects that would stimulate student interest. Providing students with interesting and unique research projects can be a strategy for generating STEM affinity and identity among underrepresented students.

5.4 Connecting to Faculty

Several studies have found that research with faculty allow students to make

connections and important mentor relationships (Chemers et al., 2011; Hurtado et al., 2011; Lane, 2016). The current study supports these findings as well. Both faculty and students discussed how these connections helped to build a sense of STEM community and identity because mentors were able to empower students to be independent in their research and become critical thinkers and contributors to science. Lane (2016) specified that programs that are able to be "catalysts" for STEM identity development provide praise, encouragement, and build research skills for students. UR STEM was able to provide these components as well and thus fostered and developed STEM identity for student participants. And when one student expressed limited contact and connection with her faculty researcher, she ultimately voiced a dissatisfaction with the experience. This limited interaction and validation from the faculty researcher likely influenced her science identity. This is similar to the work of Carlone and Johnson (2007) who found that women of color who received validation and recognition from perceived important others, were more likely to identify as scientists than those who did not. My findings suggest that validation from faculty can indeed influence student science identity and the lack there of.

Faculty who were able to empower their students to conduct research independently and problem solve noticed an increase in student science identity. These findings align with Gutierrez (2009) critical axis between power and identity, where students are empowered to bring their full "frames of reference" into doing math and thus becoming critical citizens in order to "change the game" of mathematics. Similarly, UREs that allow underrepresented students to work independently and use their own frames of reference to build science identity and improve STEM persistence.

5.5 Building Relationships with Peers

Sense of community and belongingness also were developed through relationships with peers. Students who were able to conduct research within a lab setting expressed affinity with their program major departments because of the relationships they were able to build with other students. One faculty researcher discussed her use of "near peer" mentoring that allowed upper level students to mentor the early entry students. Leggett and her colleagues (2015) found that a summer bridge program that partnered two-year community college students with four-year college students were able to cultivate a sense of science identity and confidence in research among the two-year college students. Furthermore, these students indicated an increase likelihood to transition to a four-year institution and thus progressing through STEM. My findings also suggest that establishing near peer experiences for early researchers can be a key strategy for increasing STEM persistence among underrepresented students.

5.6 Understanding Science Nomenclature

Several students within the present study discussed an initial struggle with trying to navigate the technical scientific language found in research articles and literature. Understanding discipline specific nomenclature can be a barrier for early researchers and specifically underrepresented students in STEM (Falconer, 2019). Students and faculty alike discussed how faculty can help guide students through understanding the discipline discourse and terminology. These findings suggest adding intentional parameters in place to help students better understand how to read research articles and how to search discipline related databases.

5.7 Who can be a scientist?

Students expressed an increase in science identity by participating in a research experience. These findings support Chemers et al. (2011) model stating the effects of support mechanisms, such as UREs, are mediated by students' self-efficacy and identity. However, although students reported an increase in their science identity, many of them still struggled to title themselves as scientist after completing the summer research program. Several students contributed this internal dissonance to the scientist stereotypes often portrayed in media. This suggests that science identity is not on a steady incline or decline, but perhaps science identity occurs in ebb and flows. Robinson and her colleagues (2018) were one of the first to recognize that science identity can increase or decline over a course of time, such as a student's undergraduate study career. My research furthers this finding by suggesting that science identity is even more fluid and can increase or decline even within one experience. This is particularly clear from ST, who spoke about moments throughout the research experience where she felt less

confident or sure of herself. This finding infers the need to intentionally help students overcome moments of doubt within the research experience. These appear to occur during the initial part of the experience, when students are reviewing the often dense scientific research articles, as well as during the troubleshooting phase and preparing for the final presentation. Providing students with guides or best practices for reading scientific articles, troubleshooting and preparing for presentations could aid in circumventing some of these doubts and declines in their science identity. Some faculty expressed perhaps needing to be more explicit about what it takes to be a scientist and intentionally dispelling the stereotypes of who can be a scientist that are portrayed within society.

5.8 STEM Persistence: Barriers and Solutions to URE Participation

Faculty discussed several barriers that potentially limits who participates in undergraduate research. One of these was timing of the student application. Often students from underrepresented backgrounds, such as first generation or economically disadvantaged students might not consider summer research opportunities in February. Furthermore, students who are financial contributors within their household need experiences that are paid and full-time. My findings suggest that institutions should consider paid research experiences in order to meet the needs of students with financial responsibilities. Paid research can help diversify the student application pool and ensure more underrepresented students receive the early experiential learning opportunities that will help them to persist in STEM. Furthermore, as suggested by one of the faculty researchers in this study, partnering with institutional departments such as advising, communication about these activities and be shared with students who might not think

about these experiences so early in the year.

5.9 URE Benefits and Barriers for Faculty

UREs have benefits for faculty as well. For example, faculty can use UREs to help advance their own research work and to create a sense of collegiality among their fellow faculty members. Specifically, projects that have small time commitments are more likely to appeal to faculty, who are often limited in the time they can give outside of their typical faculty duties. I suggest institutions who want to up-scale their experiential learning activities consider "mini projects" or activities that only require a small time commitment for faculty. Furthermore, institutions must consider tenure and promotion systems that reward undergraduate research. Implementing policies that reward research with undergraduate students will likely see more faculty participation in these types of activities. These findings align with previous research on the factors that influence faculty participation in student research (Hurtado et al., 2011).

5.10 Understanding how UREs influence STEM persistence: URE Process Model

The data from the present study suggests that providing students with these early opportunities can improve sense of belonging and science identity in underrepresented students and contribute to STEM persistence. Students who participated in the URE were often unsure if research was something that they wanted to pursue as a career. Others spoke about wanting to learn if they could actually do research. UR STEM gave them a safe place to learn and practice their budding research skills. When students were able to problem solve and figure out a solution, such as fixing a line of coding or work with a fellow peer to solve an issue with a piece of software, this provided validation for these

students that they can do research. Each student spoke about some form of obstacle they were able to overcome either on their own or with the assistance of their faculty researcher. The issue may have initially negatively influenced their science identity or sense of belonging, such as grappling with the terminology in a scientific research article, but with guidance from faculty or peer, the student was able to resolve the issue, which then strengthen and improved their sense of belonging to the science community and science identity. Even ST, who voiced dissatisfaction with the undergraduate research experience, still enjoyed the presentation component of the UR STEM program, as it was this experience where she was able to meet more faculty within her department and receive accolades for her research. The momentary dip in her science identity did not last long and she was able to recover and continue to persist in her STEM field. ST's experience suggest that even a declining science identity can still ultimately be recovered when influenced by positive faculty and peer interactions. This is supported by Carlone and Johnson (2007) as well as the faculty within this research. Faculty researchers often recognized the importance of their roles to be a guidepost and encourager throughout the research experience. Students who were satisfied with their experiences often contributed their positive experiences to working with faculty that were able to give them independence and guidance. This balancing act is not always easy, as two of the students within this study spoke about either not having enough independence or too much independence within the research project. I found that students need a certain amount of independence in order to learn how to problem solve and create their own solutions. This troubleshooting experience helped students to build their science identity. Being able to solve a problem on their own or to provide input on how the problem could be resolved,

helped students to feel more like a scientist. They began to recognize that they had the skills and capacity to solve scientific problems. Faculty researcher FA called this process "demystifying research" or the revelation that anyone can do research, it is not confined to a specific demographic of individuals, such as White males. Students within this study became more confident when they were able to accomplish processes within the project.

Another influence on sense of belonging and science identity found within this study was the use of hobbies and other interests within the research projects. Faculty researcher FN talked about how he and his colleague used a common hobby as a source of a research project in order to build interest among students. He recognized the importance of joining interests to science in order to help students feel more connected to the field. This is particularly important for underrepresented students in STEM, who might feel as though they can't "see themselves" within the sciences. Students SF and SY talked about how they enjoyed being able to work on a research project that was related to their interests and hobbies. This created a sense of excitement and connection for both students, particularly SY, who enjoyed working with other students and faculty around the hobby. This gave SY a sense of community and because he was able to bring his current knowledge of the hobby into the research project, this helped to increase his science identity as well. For SF, she talked about previously wanting to find ways to connect her STEM major to her hobby and this was the perfect opportunity for her to do so. As a result of the study, she is now looking for more opportunities and STEM career paths to allow her to connect her hobby and the STEM field. Using student interests and hobbies allows students to make a personal connection to STEM and thus increases their chances to persist in STEM.

These experiences are reflected within the URE process model. This model acknowledges the support components that influence science identity and sense of belonging psychological process that contributes to STEM persistence. It also acknowledges the psychological process of a wavering science identity and how science identity can ebb and flow within the research experience, particularly for a budding scientist. Faculty speak about the importance of supporting students throughout the process and encouraging them to take on challenges and work through the "messiness of science". Building these skills within students increases their confidence in conducting research and thus increasing their science identity. This is similar to Chemers' et al. (2011) findings where students who saw an increase in their research skills reported higher science identity and a higher commitment to a STEM career. My study suggests that the URE components of "doing" research, foot in the door opportunities, connecting to faculty, building relationships with peers, understanding science nomenclature, and career exploration can influence the science identity and sense of belonging psychological process and thus contribute to STEM persistence. Having an in-depth understanding of which components of URE's contribute to these psychological factors and STEM persistence is critical for practitioners as they develop their own URE programs.

5.11 Limitations

The present study does contain some limitations. The case study methodology used in this study does limit the generalizability of the findings. While the results of this study closely align with previous research findings related to research experiences of students from underrepresented groups within STEM, these findings will need to be

confirmed through additional research. Furthermore, the current study focused on students who participated in UR STEM to better understand STEM experiential learning programs and thus the findings do not include the experiences of nonparticipants. Additionally, there were limited representation of URM and economically disadvantaged (i.e. Pell recipients) students within the study, with only one student in each category. This limits the inferences that can be made related to students within these demographic categories. Also, although the program serves first generation students, this student group was not represented in the student sample. This could be due to the collecting of these data during a global pandemic that has resulted in the institution and program conducting university business virtually. As described by Grineski et al. (2017), first generation students often have smaller stock on the cultural capital needed to navigate academia. Therefore, by adding the stressors and strain of a pandemic and operating college from a virtual space, first generation students might be less likely to take on additional tasks such as participating in a research study. However, I believe by including faculty within this research study, I am still able to capture a holistic picture of the influences of the program on underrepresented students within STEM.

5.12 Implications and Recommendations for Future Research

The findings of the present research can help institutional administrators up-scale experiential learning activities on their campuses by including the success factors identified in this study and utilizing the URE process model. Furthermore, understanding the psychosocial factors of science identity and STEM community on persistence for underrepresented students can help administrators consider activities that promote confidence and belongingness in STEM. The current study provides strategies that UR

STEM is implementing to promote persistence as NKU, thus NKU can mimic these strategies in their plans to expand experiential learning on campus. The proposed program components also can be used to assess and evaluate other experiential learning programs. These components can serve as a framework to ensure that the appropriate mechanisms are in place to promote student success for underrepresented students in STEM.

As previously stated, due to the limitation of generalizability of a case study analysis, additional research conducted on a larger scale is needed. Furthermore, studies that include first generation students might find slightly different findings. I also recommend similar in-depth analysis with other experiential learning activities such as internships, clinicals, and study abroad. There are numerous studies that conclude that experiential learning activities promote student persistence, especially for underrepresented students in STEM (Fechheimer et al., 2011; Ghee et al., 2016; Museus et al., 2011). More research is warranted to understand why these particular activities are so successful. The current study is one of the first to investigate the components of these programs to identify their success factors. In order to fully understand these factors, more research is warranted.

APPENDICES

APPENDIX 1. STUDENT SURVEY INFORMED CONSENT

Consent to Participate in a Research Study

KEY INFORMATION FOR Persistence in STEM: Exploration of the Impact of a Summer Research Program:

We are asking you to choose whether or not to volunteer for a research study about your participation and experiences in a summer research program. The purpose of the study is to explore participants' experiences in a summer research program at your university.

We are asking you because you are a current or former participant of a summer research program. This page is to give you key information to help you decide whether to participate. We have included detailed information after this page. Ask the research team questions. If you have questions later, the contact information for the research investigator in charge of the study is below.

WHAT IS THE STUDY ABOUT AND HOW LONG WILL IT LAST?

The purpose of this study is to explore the impact of the participation of students within a summer research program. The expectation, if you choose to participate, is to complete a brief survey asking for demographic data about you. The survey will take approximately one to two minutes to complete. You also may skip any survey question you wish to for any reason.

Once you have completed the survey, you might be contacted for an interview. If you are selected to participate in the interview session and you choose to participate in the interview, the interview will last about 60 minutes that will ask questions about your experiences in the summer research program and the involvement of faculty and others within the program as they relate to your experiences and career development. Some questions will focus on your thoughts and feelings on various topics, and you are under no obligation to answer questions you do not wish to answer.

By doing this study, we hope to learn more about how students' participation in summer research programs influence their career path. Your participation in this research will last about one hour. The interview will be video recorded and transcribed by the principal investigator.

WHAT ARE KEY REASONS YOU MIGHT CHOOSE TO VOLUNTEER FOR THIS STUDY?

You will get the opportunity to participate in a research study and provide valuable feedback about participating in a summer research program.

WHAT ARE KEY REASONS YOU MIGHT CHOOSE NOT TO VOLUNTEER FOR THIS STUDY?

There are no perceived potential risks or discomforts related to this survey.

DO YOU HAVE TO TAKE PART IN THE STUDY?

You do not have to participate in completing the demographics survey, nor are you required to participate in the interview session if you are selected. If you are selected and you decide to take part in the study, it should be because you really want to volunteer. You will not lose any services, benefits, or rights you would normally have if you choose not to volunteer.

As a student, if you decide not to take part in this study, your choice will have no effect on your academic status, class grade(s), or program status.

WHO WILL SEE THE INFORMATION THAT YOU GIVE?

When we write about or share the results from the study, we will write about the combined information. We will keep your name and other identifying information private, no one beyond the research team, which includes the principal investigator and faculty advisor, will have access to these data. Individual data and identifiers will not be shared with program administrators nor faculty. We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. Once the demographic data are collected, your name will be removed from the data and a unique identifier code will be assigned. A coding key will be stored separately from your demographic data. Any information that is obtained in connection with this study and that can be identified with you will remain confidential. You will not be personally identified. Demographic data will be kept on record with the PI for six years, as required by the IRB. These data will be stored on an electronic password protected storage device. Program staff, including the director and other administrative staff, as well as program faculty, will not have access to participant demographic data nor knowledge of your research participation.

CAN YOU CHOOSE TO WITHDRAW FROM THE STUDY EARLY?

We hope to receive completed surveys from about 17 students, so your answers are important to us. You can choose to leave the study at any time. You will not be treated differently if you decide to stop taking part in the study. You can skip any survey question for any reason you wish.

WHAT IF YOU HAVE QUESTIONS, SUGGESTIONS OR CONCERNS?

If you have questions, suggestions, or concerns regarding this study or you want to withdraw from the study contact the study's principal investigator Cori Henderson of the University of Kentucky, Department of Educational Policy Studies and Evaluation at cori.henderson@uky.edu, or the faculty advisor Dr. John Thelin at john.thelin@uky.edu.

If you have any concerns or questions about your rights as a volunteer in this research, contact staff in the University of Kentucky (UK) Office of Research Integrity (ORI) between the business hours of 8am and 5pm EST, Monday-Friday at 859-257-9428 or toll free at 1-866-400-9428.

ARE THERE REASONS WHY YOU WOULD NOT QUALIFY FOR THIS STUDY?

Students who have not participated in or are not current participants in the UR STEM program are not eligible for the study.

WHERE WILL THE STUDY TAKE PLACE AND WHAT IS THE TOTAL AMOUNT OF TIME INVOLVED?

The survey will be conducted via online. The demographics survey will take no longer than five minutes to complete. Once you have completed the demographic survey, you might be contacted to participate in the interview segment of the research study. The interview session will be conducted via teleconference and will take about 60 minutes to complete.

WHAT WILL YOU BE ASKED TO DO?

Participants will be asked to complete an online survey form to collect demographic information. If you are selected to participate in the interview, you will be asked a series of questions related to your experiences within the summer research program. Some of these questions will be related to sense of belonging and science identity within STEM.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

There are no perceived potential risks or discomforts related to this study.

WILL YOU BENEFIT FROM TAKING PART IN THIS STUDY?

You will not get any personal benefit from taking part in this study.

IF YOU DON'T WANT TO TAKE PART IN THE STUDY, ARE THERE OTHER CHOICES?

If you do not want to be in the study, there are no other choices except not to take part in the study.

WHAT WILL IT COST YOU TO PARTICIPATE?

There are no costs associated with taking part in this study.

WILL YOU RECEIVE ANY REWARDS FOR TAKING PART IN THIS STUDY?

You will not receive any rewards or payment for taking part in the study.

WHAT ELSE DO YOU NEED TO KNOW?

The Principle Investigator is a student and she is being guided in this research by Dr. John Thelin. There may be other people on the research team assisting at different times during the study.

WILL YOUR INFORMATION BE USED FOR FUTURE RESEARCH?

Your information collected for this study will NOT be used or shared for future research studies, even if we remove the identifiable information like your name.

INFORMED CONSENT

By proceeding with the survey, you indicate your consent to participate in this research.

APPENDIX 2. STUDENT INTERVIEW CONSENT FORM

Consent to Participate in a Research Study

KEY INFORMATION FOR: Persistence in STEM: Exploration of the Impact of a Summer Research Program:

We are asking you to choose whether or not to volunteer for a research study about your participation and experiences in a summer research program. The purpose of the study is to explore participants' experiences in a summer research program at your university.

We are asking you because you are a current or former participant of a summer research program. This page is to give you key information to help you decide whether to participate. We have included detailed information after this page. Ask the research team questions. If you have questions later, the contact information for the research investigator in charge of the study is below.

WHAT IS THE STUDY ABOUT AND HOW LONG WILL IT LAST?

The purpose of this study is to explore the impact of the participation of students within a summer research program. The expectation, if you are selected to participate and you choose to do so, will be an interview lasting about 60 minutes that will ask questions about your experiences in the summer research program and the involvement of faculty and others within the program as they relate to your experiences and career development. Some questions will focus on your thoughts and feelings on various topics, and you are under no obligation to answer questions you do not wish to answer.

By doing this study, we hope to learn more about how students' participation in summer research programs influence their career path. Your participation in this research will last about one hour. The interview will be video recorded and transcribed by the principal investigator.

WHAT ARE KEY REASONS YOU MIGHT CHOOSE TO VOLUNTEER FOR THIS STUDY?

You will get the opportunity to participate in a research study and provide valuable feedback about participating in a summer research program.

WHAT ARE KEY REASONS YOU MIGHT CHOOSE NOT TO VOLUNTEER FOR THIS STUDY?

There are no perceived potential risks or discomforts related to this interview.

DO YOU HAVE TO TAKE PART IN THE STUDY?

If you are selected and you decide to take part in the study, it should be because you really want to volunteer. You will not lose any services, benefits, or rights you would normally have if you choose not to volunteer.

As a student, if you decide not to take part in this study, your choice will have no effect on your academic status, class grade(s), or program status.

WHO WILL SEE THE INFORMATION THAT YOU GIVE?

When we write about or share the results from the study, we will write about the combined information. We will keep your name and other identifying information private, no one beyond the research team, which includes the principal investigator and faculty advisor, will have access to these data. Individual interview data and identifiers will not be shared with program administrators nor faculty. We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. Due to the use of Zoom for interviews: Please be aware, while we make every effort to safeguard your data, the interview is being conducted via an online medium, as with anything involving the Internet, we can never guarantee the confidentiality of the data while still on the company's servers, or while en route to either them or us. It is also possible the raw data collected for research purposes may be used for marketing or reporting purposes by the data gathering company after the research is concluded, depending on the company's Terms of Service and Privacy policies. Any information that is obtained in connection with this study and that can be identified with you will remain confidential. You will not be personally identified. When referencing the interview in the report, the interviewee will only be identified by a fictional name. Demographic data will only be reported in the aggregate. All data will be stored on an electronic password protected storage device. Once interview data are transcribed, audio and video records will be destroyed. Written transcripts will be kept on record with the PI for six years, as required by the IRB. Transcripts will be stored on an electronic password protected storage device. Program staff, including the director and other administrative staff, as well as program faculty, will not have access to participant interview and demographic data nor knowledge of your research participation.

CAN YOU CHOOSE TO WITHDRAW FROM THE STUDY EARLY?

We hope to receive completed surveys from about 17 students, so your answers are important to us. You can choose to leave the study at any time. You will not be treated differently if you decide to stop taking part in the study. You can skip any interview question for any reason you wish.

WHAT IF YOU HAVE QUESTIONS, SUGGESTIONS OR CONCERNS?

If you have questions, suggestions, or concerns regarding this study or you want to withdraw from the study contact the study's principal investigator Cori Henderson of the University of Kentucky, Department of Educational Policy Studies and Evaluation at cori.henderson@uky.edu, or the faculty advisor Dr. John Thelin at john.thelin@uky.edu.

If you have any concerns or questions about your rights as a volunteer in this research, contact staff in the University of Kentucky (UK) Office of Research Integrity (ORI) between the business hours of 8am and 5pm EST, Monday-Friday at 859-257-9428 or toll free at 1-866-400-9428.

ARE THERE REASONS WHY YOU WOULD NOT QUALIFY FOR THIS STUDY?

Students who have not participated in or are not current participants in the UR STEM program are not eligible for the study.

WHERE WILL THE STUDY TAKE PLACE AND WHAT IS THE TOTAL AMOUNT OF TIME INVOLVED?

The research procedures will be conducted via teleconferencing. You will need to be interviewed one (1) time during the study. The interview will take about 60 minutes. Including the time spent completing the demographics survey, the total amount of time you will be asked to volunteer for this study is 65 minutes over the next two months. A follow up email or conversation might occur to assist with clarifying details from the interview. The interview will be audio and video recorded.

WHAT WILL YOU BE ASKED TO DO?

Participants will be asked a series of questions related to their experiences within the summer research program. Some of these questions will be related to sense of belonging and science identity within STEM.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

There are no perceived potential risks or discomforts related to this interview.

WILL YOU BENEFIT FROM TAKING PART IN THIS STUDY?

You will not get any personal benefit from taking part in this study.

IF YOU DON'T WANT TO TAKE PART IN THE STUDY, ARE THERE OTHER CHOICES?

If you do not want to be in the study, there are no other choices except not to take part in the study.

WHAT WILL IT COST YOU TO PARTICIPATE?

There are no costs associated with taking part in this study.

WILL YOU RECEIVE ANY REWARDS FOR TAKING PART IN THIS STUDY?

You will not receive any rewards or payment for taking part in the study.

WHAT ELSE DO YOU NEED TO KNOW?

The Principle Investigator is a student and she is being guided in this research by Dr. John Thelin. There may be other people on the research team assisting at different times during the study.

WILL YOUR INFORMATION BE USED FOR FUTURE RESEARCH?

Your information collected for this study will NOT be used or shared for future research studies, even if we remove the identifiable information like your name.

INFORMED CONSENT

By proceeding with the interview, you indicate your consent to participate in this research.

APPENDIX 3. FACULTY AND ADMINISTRATION INTERVIEW CONSENT FORM

Consent to Participate in a Research Study

KEY INFORMATION FOR Persistence in STEM: Exploration of the Impact of a Summer Research Program:

We are asking you to choose whether or not to volunteer for a research study about your participation and experiences in a summer research program. The purpose of the study is to explore participants' experiences in a summer research program at your university.

We are asking you because you are a current or former participant of a summer research program. This page is to give you key information to help you decide whether to participate. We have included detailed information after this page. Ask the research team questions. If you have questions later, the contact information for the research investigator in charge of the study is below.

WHAT IS THE STUDY ABOUT AND HOW LONG WILL IT LAST?

The purpose of this study is to explore the impact of the participation of students within a summer research program. The expectation, if you choose to participate, will be an interview lasting about 60 minutes that will ask questions about your experiences in the summer research program and the involvement of students, faculty and others within the program as they relate to student self- efficacy and development as scientists. Some questions will focus on your thoughts and feelings on various topics, and you are under no obligation to answer questions you do not wish to answer.

By doing this study, we hope to learn more about how students' participation in summer research programs influence their career path. Your participation in this research will last about one hour. The interview will be video recorded and transcribed by the principal investigator.

WHAT ARE KEY REASONS YOU MIGHT CHOOSE TO VOLUNTEER FOR THIS STUDY?

You will get the opportunity to participate in a research study and provide valuable feedback about participating in a summer research program.

WHAT ARE KEY REASONS YOU MIGHT CHOOSE NOT TO VOLUNTEER FOR THIS STUDY?

There are no perceived potential risks or discomforts related to this interview

DO YOU HAVE TO TAKE PART IN THE STUDY?

If you decide to take part in the study, it should be because you really want to volunteer. You will not lose any services, benefits, or rights you would normally have if you choose not to volunteer. Your choice to participate or not will not impact your employment status with the program.

WHO WILL SEE THE INFORMATION THAT YOU GIVE?

When we write about or share the results from the study, we will write about the combined information. We will keep your name and other identifying information private, no one beyond the research team, which includes the principal investigator and faculty advisor, will have access to these data. Individual interview data and identifiers will not be shared with program administrators. We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. Due to the use of Zoom for interviews: Please be aware, while we make every effort to safeguard your data, the interview is being conducted via an online medium, as with anything involving the Internet, we can never guarantee the confidentiality of the data while still on the company's servers, or while en route to either them or us. It is also possible the raw data collected for research purposes may be used for marketing or reporting purposes by the data gathering company after the research is concluded, depending on the company's Terms of Service and Privacy policies. Any information that is obtained in connection with this study and that can be identified with you will remain confidential. You will not be personally identified. When referencing the interview in the report, the interviewee will only be identified by a fictional name, and the data will be stored on an electronic password protected storage device. Once interview data are transcribed, audio and video records will be destroyed. Written transcripts will be kept on record with the PI for six years, as required by the IRB. Transcripts will be stored on an electronic password protected storage device. Only the research team will have access to the raw data. Program staff, including the director and other administrative staff, will not have access to participant interview data nor knowledge of your research participation.

CAN YOU CHOOSE TO WITHDRAW FROM THE STUDY EARLY?

You can choose to leave the study at any time. You will not be treated differently if you decide to stop taking part in the study. You can skip any interview question for any reason you wish.

WHAT IF YOU HAVE QUESTIONS, SUGGESTIONS OR CONCERNS?

If you have questions, suggestions, or concerns regarding this study or you want to withdraw from the study contact the study's principal investigator Cori Henderson of the University of Kentucky, Department of Educational Policy Studies and Evaluation at cori.henderson@uky.edu, or the faculty advisor, Dr. John Thelin at john.thelin@uky.edu.

If you have any concerns or questions about your rights as a volunteer in this research, contact staff in the University of Kentucky (UK) Office of Research Integrity (ORI) between the business hours of 8am and 5pm EST, Monday-Friday at 859-257-9428 or toll free at 1-866-400-9428.

ARE THERE REASONS WHY YOU WOULD NOT QUALIFY FOR THIS STUDY?

Individuals who have not participated in or are not current participants in the UR STEM program are not eligible for the study.

WHERE WILL THE STUDY TAKE PLACE AND WHAT IS THE TOTAL AMOUNT OF TIME INVOLVED?

The research procedures will be conducted at Northern Kentucky University main campus or via teleconferencing. You will need to come one (1) time during the study. The interview will take about 60 minutes. The total amount of time you will be asked to volunteer for this study is 60 minutes over the next two months. A total of no more than two follow up contacts might be made to validate data collected in the interview. The interview will be audio and video recorded.

WHAT WILL YOU BE ASKED TO DO?

Participants will be asked a series of questions related to their experiences within the summer research program. Some of these questions will be related to student sense of belonging in STEM and identity as a scientist.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

There are no perceived potential risks or discomforts related to this interview.

WILL YOU BENEFIT FROM TAKING PART IN THIS STUDY?

You will not get any personal benefit from taking part in this study.

IF YOU DON'T WANT TO TAKE PART IN THE STUDY, ARE THERE OTHER CHOICES?

If you do not want to be in the study, there are no other choices except not to take part in the study.

WHAT WILL IT COST YOU TO PARTICIPATE?

There are no costs associated with taking part in this study.

WILL YOU RECEIVE ANY REWARDS FOR TAKING PART IN THIS STUDY?

You will not receive any rewards or payment for taking part in the study.

WHAT ELSE DO YOU NEED TO KNOW?

The Principle Investigator is a student and she is being guided in this research by Dr. John Thelin. There may be other people on the research team assisting at different times during the study.

WILL YOUR INFORMATION BE USED FOR FUTURE RESEARCH?

Your information collected for this study will NOT be used or shared for future research studies, even if we remove the identifiable information like your name.

INFORMED CONSENT

By proceeding with the interview, you indicate your consent to participate in this research.

APPENDIX 4. STUDENT DEMOGRAPHIC SURVEY

Please complete the following information to the best of your ability.

Q1

○ First Name _____

○ Last Name _____

Q2 What is your current student classification?

○ Freshman (0-29 credit hours earned)

○ Sophomore (30-59 credit hours earned)

○ Junior (60-89 credit hours earned)

○ Senior (90 or more credit hours earned)

Q3 Gender:

○ Female

○ Male

○ Non-binary

○ Gender fluid

○ Prefer not to say

○ Prefer to self-describe as:

_____

Q3 Race/ethnicity (select all that apply):

- [ ] African American or Black
- [ ] American Indian or Alaska Native
- [ ] Asian
- [ ] Hispanic or Latino
- [ ] Native Hawaiian or Pacific Islander
- [ ] White

Q4 What is your current major?

_____

Q5 Are you a first generation college student?

- ○ Yes
- ○ No
- ○ Unsure

Q6 Did you receive a Pell grant this academic year?

- ○ Yes
- ○ No
- ○ Unsure

APPENDIX 5. STUDENT INTERVIEW PROTOCOL

Informed Consent

Prior to beginning the interview, I need to share with you the informed consent [proceeds to share consent form]. Now that I have shared and explained the informed consent with you do you have any questions? [answers any questions from the participant]. Do you consent to proceed with the interview? [If response is no, interview is immediately terminated]

General Questions

1. Pre-questions
    a. What has been your experience within your STEM major at NKU?
    b. Why did you apply to participate in the UR STEM program?
    c. What do you hope to gain from this experience?
2. Post-questions
    a. What did you learn from the UR STEM program?
    b. Did the UR STEM program meet your expectations? Why or why not?
    c. What does the program do well?
    d. What is the program lacking?

Sense of Belonging

3. Thinking about the UR STEM program, has it helped you to feel like you belong within the STEM community? How about within STEM at NKU? If so, how?
4. Were there times where you felt like you did not belong? Please describe.

Science Identity

5. How would you describe a scientist?
6. Do you identify yourself as a scientist? Why or why not?
7. How has the UR STEM program influenced your identity as a scientist?

STEM Persistence

8. Are you thinking about changing your major next fall? If so, what major are you considering?

APPENDIX 6: FACULTY INTERVIEW PROTOCOL

Informed Consent

Prior to beginning the interview, I need to share with you the informed consent [proceeds to share consent form]. Now that I have shared and explained the informed consent with you do you have any questions? [answers any questions from the participant]. Do you consent to proceed with the interview? [If response is no, interview is immediately terminated]

General Questions

1. How would you describe the UR STEM program?
    a. What about the program is working?
    b. What is the program lacking?

Sense of Belonging

2. Did you help students feel a sense of belonging within the summer research projects? If so, how?
3. Do you think the UR STEM program encourages faculty to create a sense of belonging with students within the summer research projects? If so, in what ways?

Science Identity

4. Did you notice a change or difference in students' identity as scientists before and after the summer research project? If so, please explain.
5. Were there ways that you tried to help students build their emerging science identity? If so, how?
6. Do you think participating in UR STEM helps students to develop their science identity? If so, please explain.

APPENDIX 7. ADMINISTRATION INTERVIEW PROTOCOL

Informed Consent

Prior to beginning the interview, I need to share with you the informed consent [proceeds to share consent form]. Now that I have shared and explained the informed consent with you do you have any questions? [answers any questions from the participant]. Do you consent to proceed with the interview? [If response is no, interview is immediately terminated]

1. Why was the UR STEM program developed?
2. What are the primary goals of the program?
3. How do you recruit prospective students to participate in the summer research program?
4. How do you determine eligibility?
5. How successful is the program at achieving its stated goals? By what criteria is success determined? To what do you attribute the program's success or lack thereof?
6. Why do you feel this program is beneficial to students?
7. Does this program help students to feel a sense of belonging? If so, how?
8. Does this program help students to develop their science identities? If so, how?
9. Is there anything else that you would like to add regarding the impact this program has on this campus?

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VITA

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Education

Northern Kentucky University Highland Heights, KY
Master of Science, Industrial Organizational Psychology, December 2015

College of Mount St. Joseph Cincinnati, OH
Bachelor of Science, Psychology, May 2008

Professional Experience

NORTHERN KENTUCKY UNIVERSITY

Associate Director, Institutional Research, December 2017-present

Assistant Director, Institutional Research, August 2016-December 2017

Analyst, Institutional Research, August 2014-August 2016

Graduate Assistant, Institutional Research, December 2013-August 2014

Graduate Assistant, Educational Leadership Department, February 2012-December 2013

BROWN MACKIE COLLEGE- NORTHERN KENTUCKY

Executive Administrative Assistant, Human Resource Department, July 2010-February 2012

Records Officer, Registrar Office, September 2008-June 2010

Presentations

Ndoye, A., Clark, S., Henderson, C., & Kwon, J. (January, 2020). The impact of non-cognitive factors on student success. Paper presented at the annual meeting of College Personnel Association of Kentucky, Highland Heights, KY.

Mulligan, E., Henderson, C., & Rainey, S. (2015, November). And they're off! Using college readiness factors to assess student momentum towards graduation. Paper presented at the annual meeting of Kentucky Association for Institutional Research, Lexington, KY.